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* indicates illustrated article.
§ indicates editorial comment.
‡ indicates communication.
† indicates a short non-illustrated article or note.

The Page Numbers for the Different Months of the Year 1911 are as Follows:

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Composite Steel Passenger Equipment

A DESIGN FOR STEEL PASSENGER CARS HAS BEEN DEVELOPED AND LARGELY STANDARDIZED BY THE AMERICAN CAR & FOUNDRY CO. WHICH INCORPORATES A VERY STIFF AND STRONG BOX GIRDER CONSTRUCTION IN THE SIDES BELOW THE BELT RAIL, THAT IS EMPLOYED FOR CARRYING THE FULL WEIGHT OF THE CAR, INCLUDING THE CENTER SILLS AND LIVE LOAD. THE CENTER SILLS ARE DESIGNED FOR PULLING AND BUFFING STRENGTH ONLY. THE VESTIBULE HOOD INCORPORATES A MALLEABLE IRON PANEL OF PARTICULAR INTEREST.

Among the designs for steel passenger cars brought out during the past two years the one developed by the American Car & Foundry Co., from which several hundred cars of various classes have been built, presents a number of points of particular interest. This design is for cars wherein the framing and exterior sheathing throughout are of steel and the interior finishing from the sash rest up is of wood, the latter, however, not being used in any connection for strength or stiffness.

In general the design follows the principles that were adopted by this company for steel passenger cars with the first examples built, viz., that the sides of the car from the belt rail to the side sill should be formed into a plate girder or truss, which would not only be self-supporting but also capable of carrying the entire load, consisting of the weight of the underframing, the superstructure and the live load. The center sills to be continuous from end to end of the car and of a size suitable for resisting the pulling and buffing stresses only, and not only are not depended upon for carrying vertical loads, but are so supported that their own weight is carried on the sides. Many designers consider that if a size of center sills sufficient for carrying the buffing strain is used, and particularly if the center line of draft is centered below the neutral axis of the sill, the center sill itself is then capable of supporting its share of the load. This would not appear to be correct because of the deflections; the lighter beam deflecting of its own weight more than the whole structure as embodied in the finished car.

Throughout the design has been very carefully studied to cheapen the manufacture, as far as possible, and to facilitate any repairs which, through accident, may be required. The arrangement is such that practically any part of the underframe can be removed without any extensive dismantling or difficulty.

Another very interesting feature of the design is found in the construction of the vestibule, wherein malleable iron hood deck panels are employed, which carry with perfect rigidity practically the entire weight of the vestibule and its parts. This construction will be discussed in detail later.

This type of design has been used successfully by the American Car & Foundry Co. on many classes of cars, including coaches, baggage, chair, combination cars, postal and diners.

Underframe.

The underframe includes two 10 in. 35 lb. I-beams, set at 16 in. centers, extending continuous between the extreme ends of the car, for carrying the pulling and buffing stresses, the draft gears being mounted between them. These center sills measure 77 ft. in length over all and are carried through and secured to the bolsters, as is shown in the illustration. The side sills are in reality the whole side structure below the windows of which the part usually termed side sills are made up of the tension members of the double side truss, the outside one being a 6 x 6 x 5/8 in. angle and the inner one, which is located on top of the bolster cross bearers, etc., and 6 3/16 in. inside of the outer sill, being a 5 x 3 x 5/8 in. angle. There are also intermediate or platform sills extending from the platform end sill to the inside section of the double body bolster. These are 8 in., 11 1/4 lb. channels.

INTERIOR OF COMPOSITE STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.

SEVENTY-FOOT STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.

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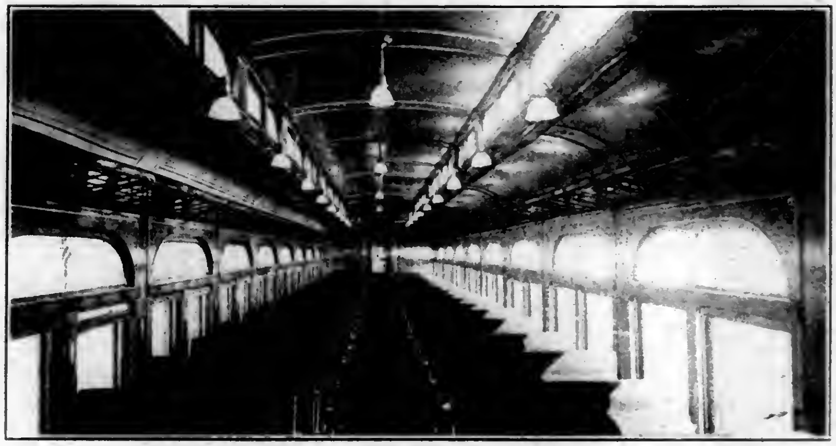

INTERIOR OF COMPOSITE STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.

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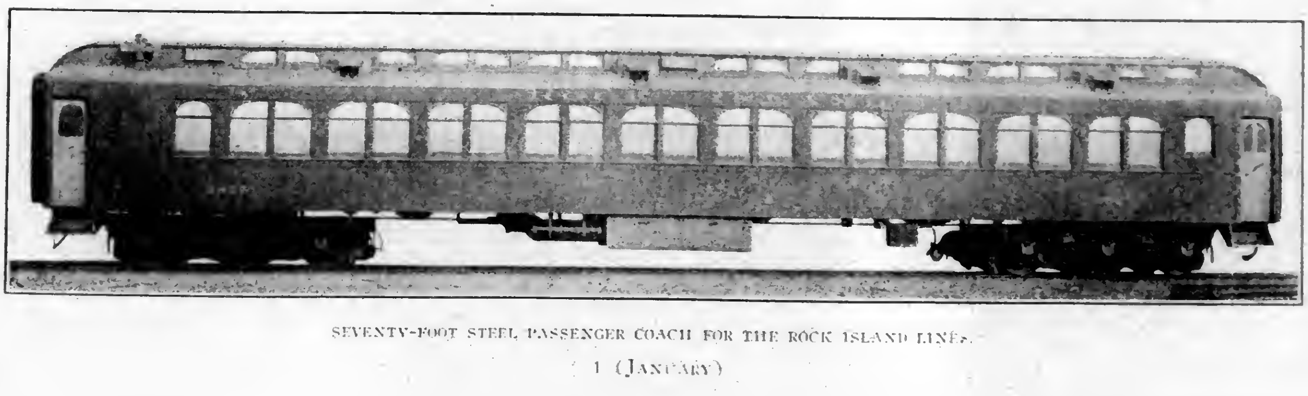
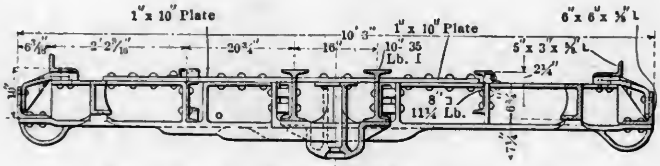
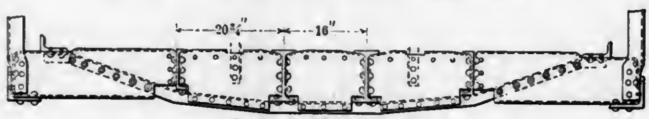


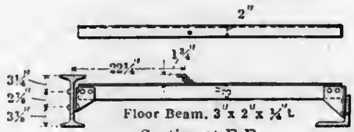
SEVENTY-FOOT STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.

Between the double body bolsters, which are located with their centers 8 ft. inside of the end sill, there are four built up cross bearers for transferring the weight of the floor and load to the side girders. These cross bearers are located at practically equal distances, being about 10 ft. 10 in. apart. As will be seen by reference to the section at this point, they are built up in box girder form, the vertical members consisting of diaphragms pressed from ¼ in. plate into a dished section and secured between the side and center sills. The compression member is a ½ in. plate 11½ in. wide and 4 ft. in length, which is continuous, passing through openings cut in the webs of the center sills. The tension member of the cross bearers is a pressed steel shape made of ¼ in. plate, which passes below the center sills, and is securely fastened to the bottom of the side sill. The vertical sides of this member are continued up and are riveted to the diaphragm plates. Reinforcing angles, 3 x 2½ x ¼ in., stiffen it on each side directly below the center sills. This construction and arrangement is clearly shown in the cross section. It will be noticed that the cross bearers are very securely fastened to the exterior side truss and that it is very well designed for either center or end loading, as may be required by service.

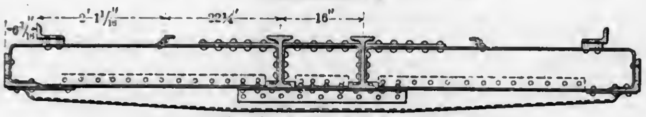


Section at A-A Sections at Bolster Section at B-B


Section at End Sill C-C

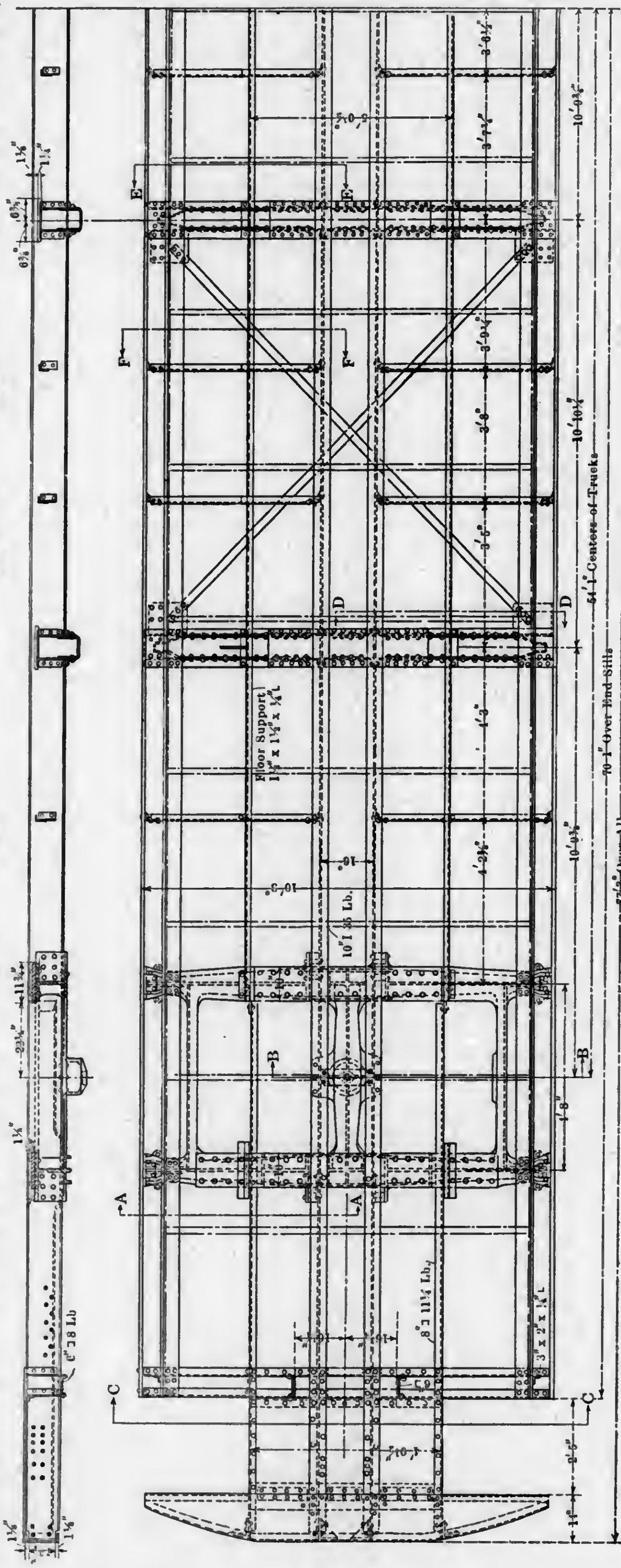


Section at F-F


D-D Section at Cross Bearer. E-E

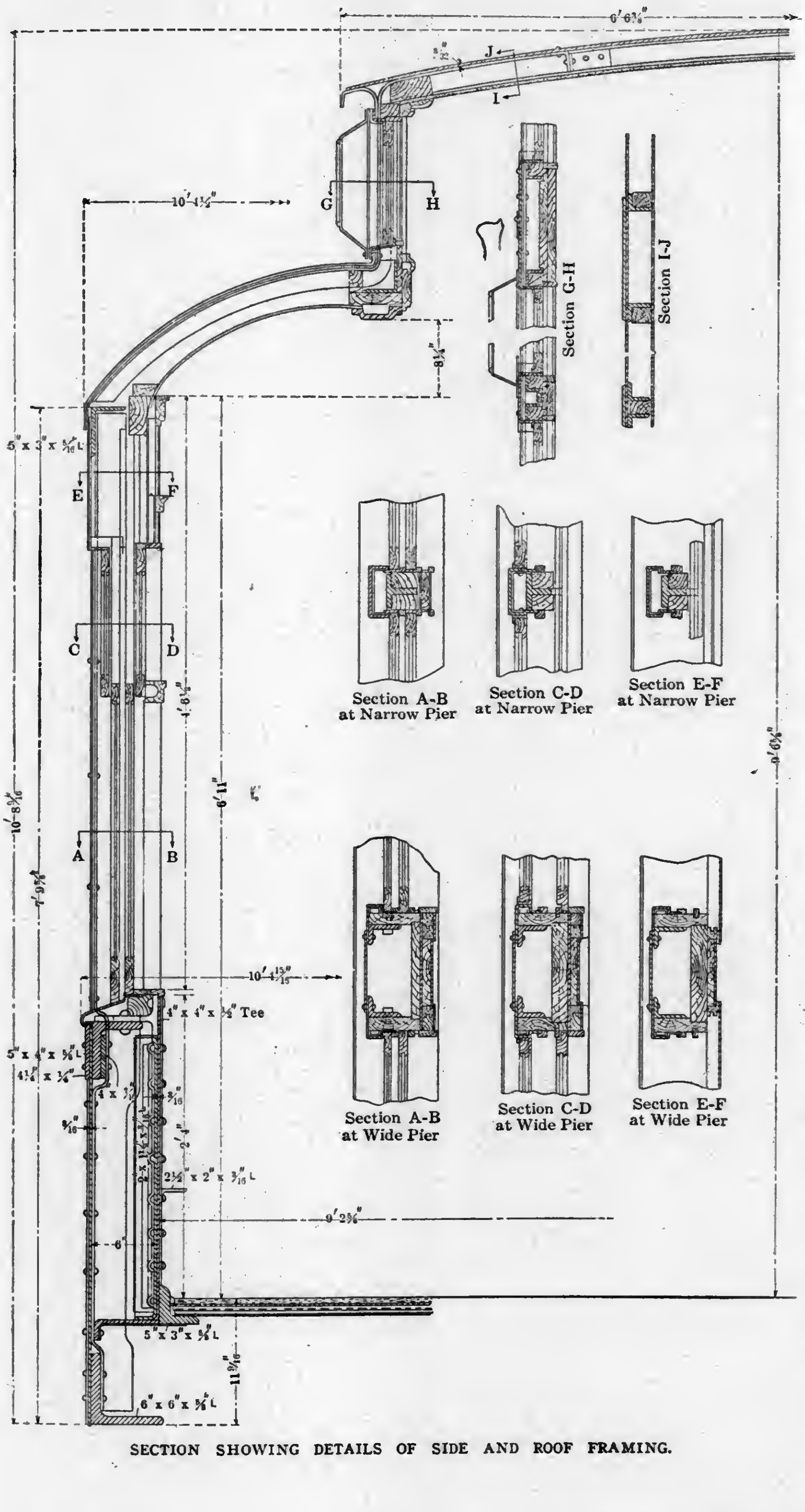
Between the cross bearers there are two floor beams, placed at practically equal distances apart and composed of a 2 x 3 x ¼ in. angle fastened by knees to the center and side sills. These are intended to act entirely as a support for the longitudinal floor beams, composed of 1½ x 1½ x ¼ in. angles extending continuous between the bolsters and equally spaced between the center and side sills.

At the end sill a box girder construction somewhat similar to the cross beams has been employed, the design, however, being entirely for center loading and arranged to transfer the load including the overhang of the center and intermediate sills, together with the end framing and part of the vestibule to the side girders. This has been done largely by means of a truss extending continuous below the center and intermediate sills and secured to their bottom flanges, carried upwards and fastened to the tension member of the inner side truss. This is formed of a 6 in., 8 lb. channel shaped and arranged as is shown in the section at this point. One-quarter inch diaphragm plates, of suitable shape, act as stiffeners between the sills and together with the floor plates make up the box girder construction. Double cast steel body bolsters of a specially light design are employed. The casting is arranged to permit the center and intermediate sills to pass continuous through the bolster, the latter, however, going through but one arm. The bolster is arranged so that either it or the sills can be removed with no great difficulty.



UNDERFRAMING FOR COMPOSITE STEEL PASSENGER EQUIPMENT.

This construction is designed to use rolled steel tension members or cover plates, the one on the outside arm of the bolster being a 1 x 10 in. plate, 7 ft. 6 in. long, the inner one being a similar size plate 4 ft. 7½ in. long. It will be noticed that while the large side sill angle is fastened directly to the bolster casting the inner one is carried by a separate small casting, although also secured to the main bolster. This small casting acts as a stiffener and spacing block between the members of the double



SECTION SHOWING DETAILS OF SIDE AND ROOF FRAMING.

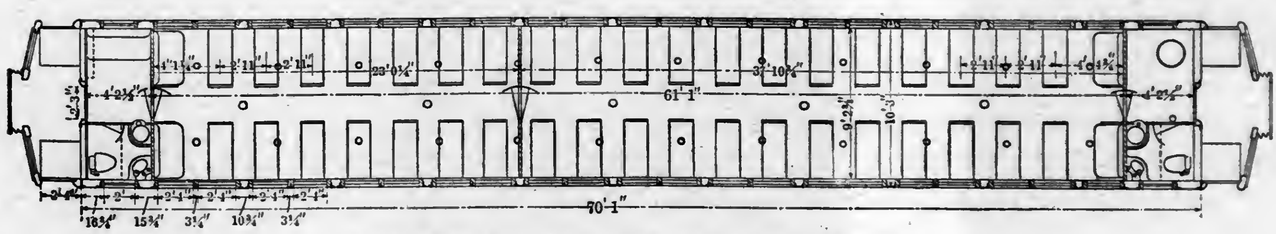
side truss at this point in the same manner as the diaphragm plates of the cross bearer and end sill also act.

The floor plates, of ¼ in. steel, are secured to the inner side sill, the floor supports, the center sills and to each other, the plates overlapping. In this manner these plates act as stiffeners of remarkable strength in the horizontal plane and hold the underframing in perfect alignment in this direction.

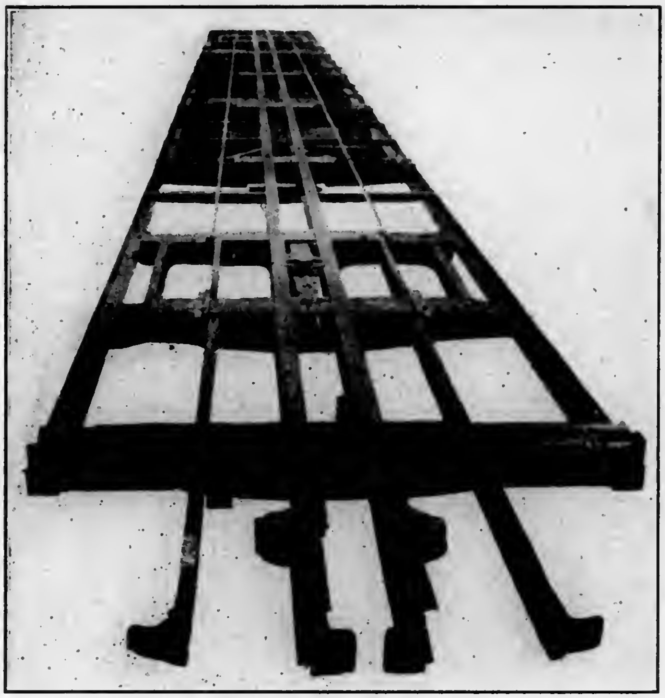
Side Framing.

As is mentioned above, one of the novelties of this design is the employment of a double side truss for load carrying which in effect produces practically a box girder giving considerable transverse stiffness as well as the vertical strength for load carrying. This is formed between the belt rail and the side sills, the outer truss, consisting of a 3/16 in. web plate, forming the sheathing of the car; the 6 x 6 x ⅝ in. side sill, which forms the tension member, and the 5 x 4 x ⅝ in. angle at the window sill, which forms the compression member. The latter is reinforced with a 4¼ x ¼ in. plate outside of the sheathing and a 4 x 7/16 in. vertical plate inside its vertical leg. The horizontal leg of this member is cut out to allow the side posts to pass through it. The side posts, which are continuous from the side sill to the plate, are formed of 3 x 2 x ¼ in. angles, and 3 x 3 in. tees and act as stiffeners to the web of this girder. The inside girder also has a 3/16 in. web plate, the 5 x 3 x ⅝ in. angle, as previously mentioned, for a tension member, and a 4 x 4 x ½ in. T for a compression member. The leg of this T is secured to the horizontal leg of the angle on the outside girder and secures the two girders together at that point. It is cut out to permit the side posts to pass through it. This girder is stiffened by 2 x 1½ x 3/16 in. L's set on an average of about 18 in. apart. At the ends these stiffeners are of 3 x 2 x ¼ in. angles continuing below the tension member and secured to the inner diaphragm of the end sill.

Above the belt rail, the side posts, which are depressed to pass around the large angle, as is shown in the illustration, continue to a 5 x 3 x 5/16 in. angle, which forms the plate. These posts are single or double, the former being 3 x 3 in. T's instead of angles, the spacing of course being arranged to suit the window opening. The latest construction of the A. C. & F. Co. does not carry the tees above the belt rail, instead the pinning is made of one piece and seated in pockets at belt rail and plate, thus saving considerable excess weight. To the steel posts are secured the wooden blocks for fastening the inside finish. The window frames are of pressed steel and are duplicates throughout the



PLAN OF ROCK ISLAND COACHES FOR USE IN THE SOUTH.



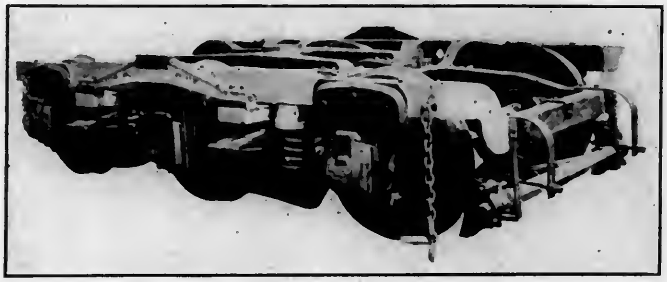
UNDERFRAME ASSEMBLED.

whole car; from inspection of the drawings it will be seen that these are so designed that they can be assembled complete on jigs before being applied to the car, thus insuring the interchangeability of the sash. The sash rest capping forming the bottom member of this construction is for this reason joined by welding in the center of each wide panel.

Roof Framing.

Continuous carlines of 1¾ x 1¼ x 3/16. in. angles formed to the proper shape are secured to the top of the plates by malleable iron knees. They are spaced to bear the same relation to each other as to the side posts. The ones over the single posts being double, set back to back with 1⅜ in. spacing pieces between. The carlines are spaced and stiffened by the deck sill, a 3 x 3 x ¼ in. angle which runs continuous for the full length of the car, and by the eaves moulding, formed of a 3/16 in. plate bent into a U shape, which is also continuous for the full length of the car and connects to the malleable iron deck hood panel, which acts as a continuation of it for the vestibule. Near the center of the carlines are two rows of purlins formed of 1¼ x 1¼ x 3/16 in. angles cut to the proper length to fit and secured by angle iron knees. This construction is varied somewhat in one end panel, where there are two cripple carlines and the purlins are spaced somewhat further apart and the reinforcement is increased. On the opposite end the construction is the same as this except that continuous carlines are employed.

Plates 1/16 in. thick are riveted directly to the carlines and other parts and form the roof sheets. These plates are butt jointed and a cover plate is secured over each joint. The upper window frames are of pressed steel and are secured to the carlines and roof sheets in the same manner as are the side window frames. One of the illustrations shows the construction at this point in detail, as well as the wooden filling blocks for the attachment of the interior finish.



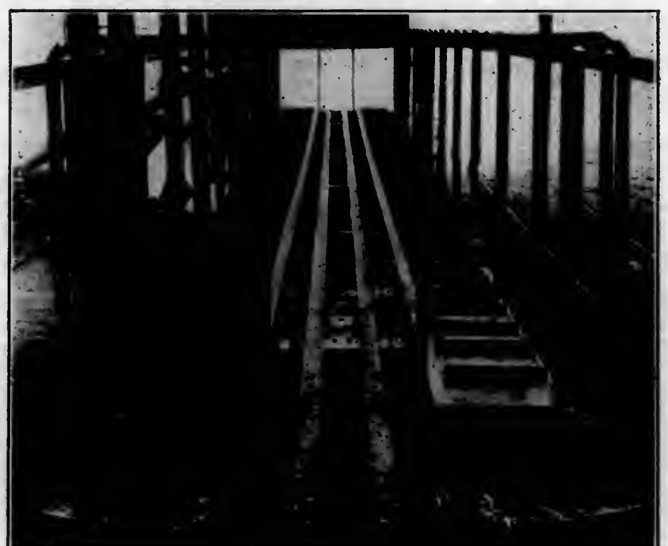
COMMONWEALTH CAST STEEL TRUCK.

Body End Framing.

Two 6 in. channels form the door posts and continue below the floor level between the diaphragms of the end sill to which they are connected. At the top they are secured to a 3 x 5 in. angle, which is formed in bow shape and fastened to the side plates. Two small angles are secured between the corner and the door posts, and act as stiffeners for the ⅛ in. steel end sheathing.

Vestibule.

As mentioned above, one of the novelties of this design is found in the malleable iron deck hood panels, the details of which are shown in one of the illustrations. These are secured to the eaves moulding, to the deck sill, the end carlines and to the end plate, and are designed to give an absolutely watertight construction as well as a very strong rigid and light support to practically the whole vestibule framing. At the outer end they are riveted to the angle forming the vestibule end plate, which in turn carries the channels forming the center door posts of the vestibule and the angle and pressed steel frame forming the outer side posts. A 10 in. channel secured to the center sills and the intermediate sills forms the vestibule end sill. The angles forming the side plates of the car are of course continued to a connection with the plate of the vestibule. In addition the vestibule construction incorporates two 4 in. channels set with their web vertical and secured to between the body door posts and



GENERAL VIEW OF FRAMING. THE INNER SIDE GIRDER IS LYING FLAT ON THE UNDERFRAME.

the end construction of the vestibule. These act as supports for the vestibule diaphragm rigging.

The sheathing, frames, etc., on the vestibule are all of steel plate, in some cases wooden blocks being secured to the framing for the attachment of the light steel finish that it may be necessary to remove in case of repairs.

Interior Finish.

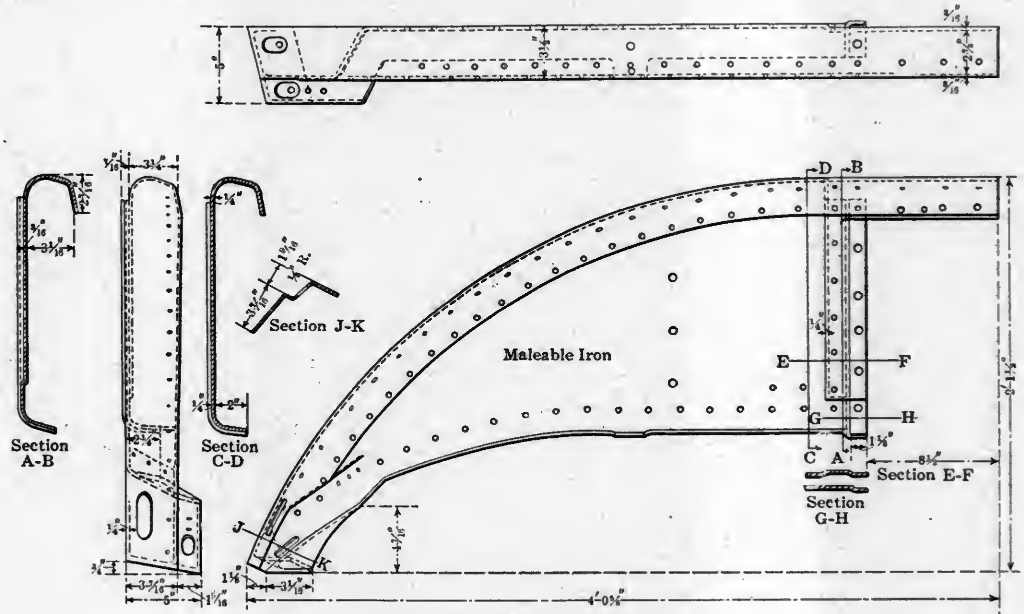
A polished mahogany veneer is used for the interior finish, this being mounted upon strips of wood bolted directly to the steel framing and arranged as is shown in the cross section. The veneer is built up with a fireproof varnish and is practically fireproof. The head lining is of agasote and the floor is of acandalith cement laid on a keystone galvanized iron flooring secured directly to the steel floor sheets.

One of the illustrations shows the interior appearance, well illustrating the artistic simplicity of the design. The cars are electric lighted, current being obtained from the axle lighting

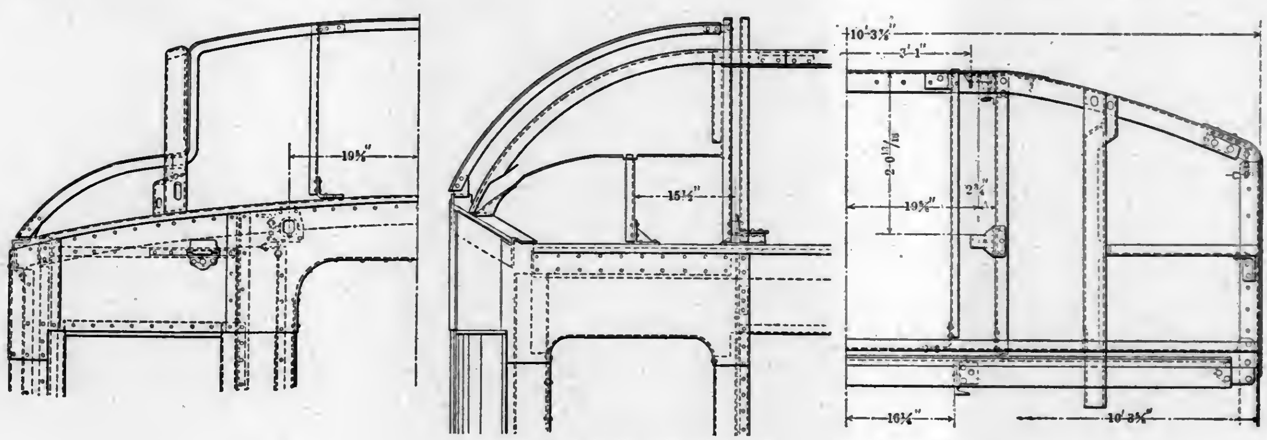
system, the generator of which is driven by a four-ply, 5 in. belt. The arrangement of the lights, the particularly attractive fixtures for which were furnished by the Adams & Westlake Co., is such as to give an even diffusion throughout the whole car. There are five single center lights, 25 single light fixtures along the deck and five hall and vestibule lights. Willard storage batteries are used in connection with the lighting system. The basket racks are bronze and 5 ft. 1¾ in. in length, so located as to be practically continuous. The Starritt reversible seats with high backs are upholstered in olive plush and a strip of Wilton carpet of the same shade is placed in the aisle.

Cast steel 6-wheeled trucks of the Commonwealth Steel Company's design are used under these cars. The general features of construction are clearly shown in the illustration.

In addition to the specialties above mentioned others which were used on the Rock Island cars are given below:



MALLEABLE IRON DECK HOOD PANEL.

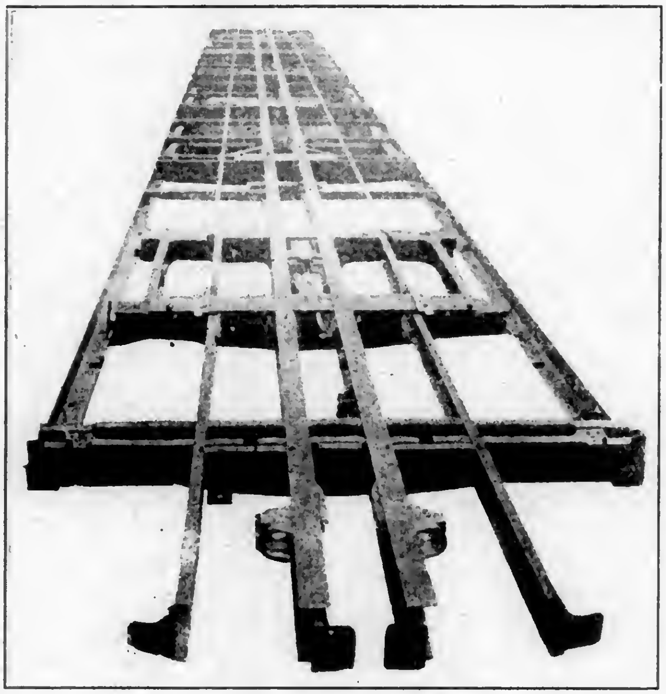


VESTIBULE HOOD CONSTRUCTION.

Draft Gear	Waugh Draft Gear Co.
Platforms	Standard Steel Co.
Window Fixtures	Edwards
Window Fixtures, Universal	Grip Nut Co.
Deck Sash Ratchet	Hart
Deck Sash Ratchet	Universal
Glass in Deck Sash and Upper Side Windows	Pressed Prism Plate Glass Co.
Couplers	Janney
Centering Device	Chaffee
Curtains	Pantasote
Roller and Side Bearings	Wood
Air Brake Equipment	New York
Steel Trap Doors	National
Ventilators	Garland
Insulation in Side Girder	Ceilinite
Insulation in Side Girder	Linofelt
Heating Equipment	Chicago Car Heating
Wiring	Kerite
Train Connectors	Gibbs
Wheels	Standard Steel Co.
Journal Boxes	McCord
Brake Beams	Waycott
Bolsters	Commonwealth
Axle Light	Safety Car Heating and Lighting Co.
Balata Belting	New York Leather Belting Co.

Many of the other interesting features of this design, including double carline at body end frame for easy removal of hood members in case of damage to the end, have been described in detail in articles we have published descriptive of cars built by this company for the New York Central Lines suburban service (Mar., 1907, p. 81) and the Long Island Railroad Coach (Feb., 1907, p. 41).

A FLUX FOR USE IN BRAZING CAST IRON can be made by mixing 1 lb. of boric acid, 4 oz. of pulverized chlorate of potash, and 3 oz. of carbonate of iron. To make a good brazed joint, the metal should be carefully cleaned and the pieces heated to a bright red before applying the flux.



UNDERFRAME ASSEMBLED.

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Roof Framing.

Continuous carlines of 1¾ x 1½ x 3/16 in. angles formed to the proper shape are secured to the top of the plates by malleable iron knees. They are spaced to bear the same relation to each other as to the side posts. The ones over the single posts being double, set back to back with 1⅜ in. spacing pieces between. The carlines are spaced and stiffened by the deck sill, a 3 x 3 x ¼ in. angle which runs continuous for the full length of the car, and by the eaves moulding, formed of a 3/16 in. plate bent into a U shape, which is also continuous for the full length of the car and connects to the malleable iron deck hood panel, which acts as a continuation of it for the vestibule. Near the center of the carlines are two rows of purlins formed of 1¼ x 1¼ x 3/16 in. angles cut to the proper length to fit and secured by angle iron knees. This construction is varied somewhat in one end panel, where there are two cripple carlines and the purlins are spaced somewhat further apart and the reinforcement is increased. On the opposite end the construction is the same as this except that continuous carlines are employed.

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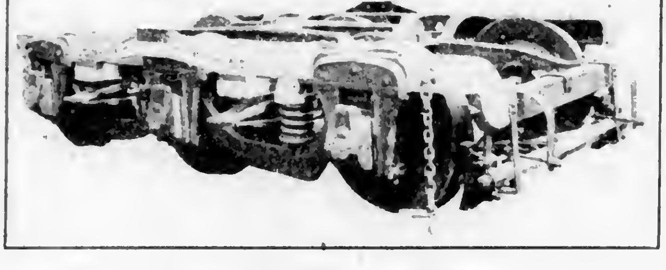

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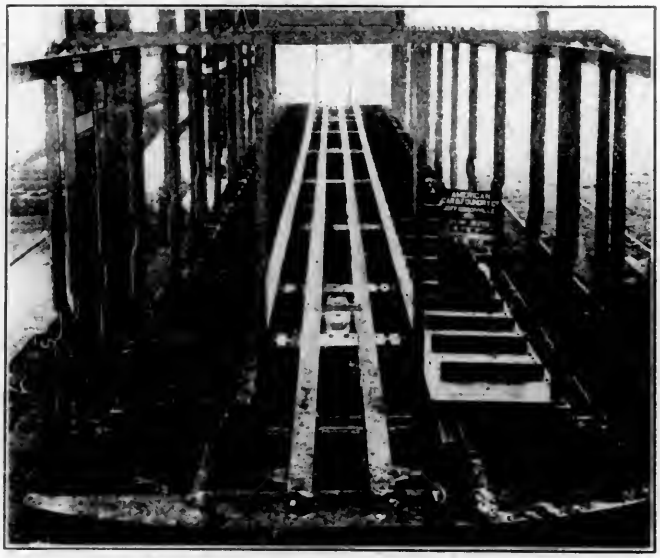

GENERAL VIEW OF FRAMING. THE INNER SIDE GIRDER IS LYING FLAT ON THE UNDERFRAME.

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A polished mahogany veneer is used for the interior finish, this being mounted upon strips of wood bolted directly to the steel framing and arranged as is shown in the cross section. The veneer is built up with a fireproof varnish and is practically fireproof. The head lining is of agasote and the floor is of acandalith cement laid on a keystone galvanized iron flooring secured directly to the steel floor sheets.

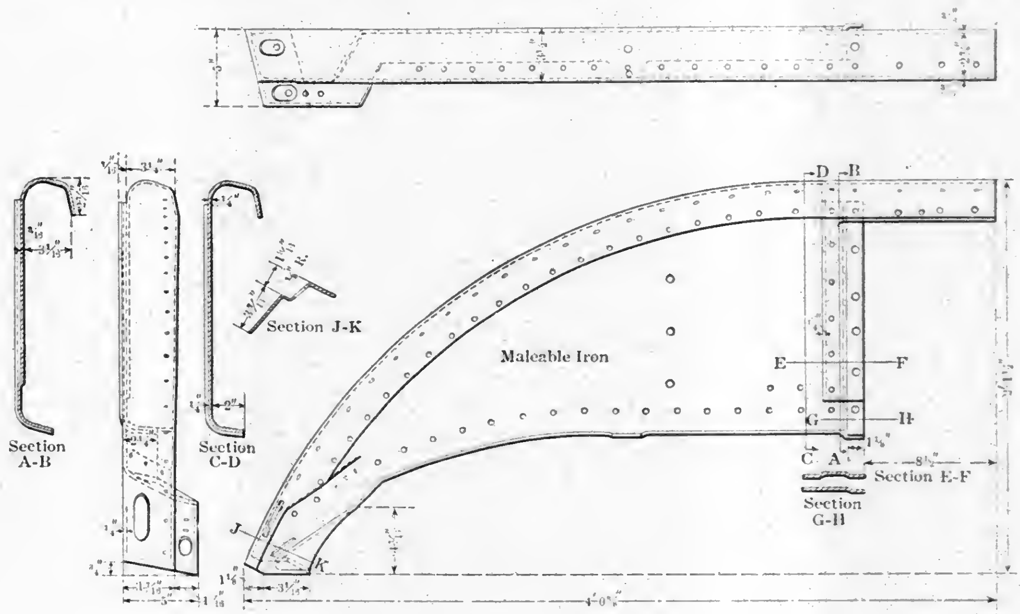
One of the illustrations shows the interior appearance, well illustrating the artistic simplicity of the design. The cars are electric lighted, current being obtained from the axle lighting

system, the generator of which is driven by a four-ply, 5 in. belt. The arrangement of the lights, the particularly attractive fixtures for which were furnished by the Adams & Westlake Co., is such as to give an even diffusion throughout the whole car. There are five single center lights, 25 single light fixtures along the deck and five hall and vestibule lights. Willard storage batteries are used in connection with the lighting system. The basket racks are bronze and 5 ft. 1¾ in. in length, so located as to be practically continuous. The Starritt reversible seats with high backs are upholstered in olive plush and a strip of Wilton carpet of the same shade is placed in the aisle.

Cast steel 6-wheeled trucks of the Commonwealth Steel Company's design are used under these cars. The general features of construction are clearly shown in the illustration.

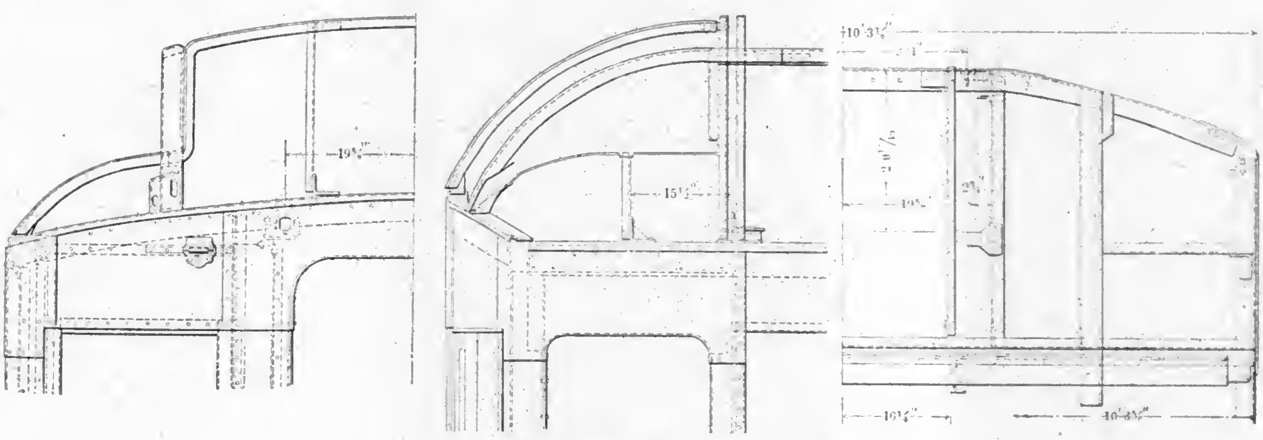
In addition to the specialties above mentioned others which were used on the Rock Island cars are given below:

Draft Gear	Waugh Draft Gear Co.
Platforms	Standard Steel Co.
Window Fixtures	Edwards
Window Fixtures, Universal	Grip Nut Co.
Deck Sash Ratchet	Hart
Deck Sash Ratchet	Universal
Glass in Deck Sash and Upper Side Windows	Pressed Prism Plate Glass Co.
Couplers	Janney
Centering Device	Chaffee
Curtains	Pantasote
Roller and Side Bearings	Wood
Air Brake Equipment	New York
Steel Trap Doors	National
Ventilators	Garland
Insulation in Side Girder	Cellulite
Insulation in Side Girder	Linofelt
Heating Equipment	Chicago Car Heating
Wiring	Kerite
Train Connectors	Gibbs
Wheels	Standard Steel Co.
Journal Boxes	McCord
Brake Beams	Waycott
Bolsters	Commonwealth
Axle Light	Safety Car Heating and Lighting Co.
Balata Belting	New York Leather Belting Co.



MALLEABLE IRON DECK HOOD PANEL.

Many of the other interesting features of this design, including double carline at body end frame for easy removal of hood members in case of damage to the end, have been described in detail in articles we have published descriptive of cars built by this company for the New York Central Lines suburban service (Mar., 1907, p. 81) and the Long Island Railroad Coach (Feb., 1907, p. 41).



VESTIBULE HOOD CONSTRUCTION.

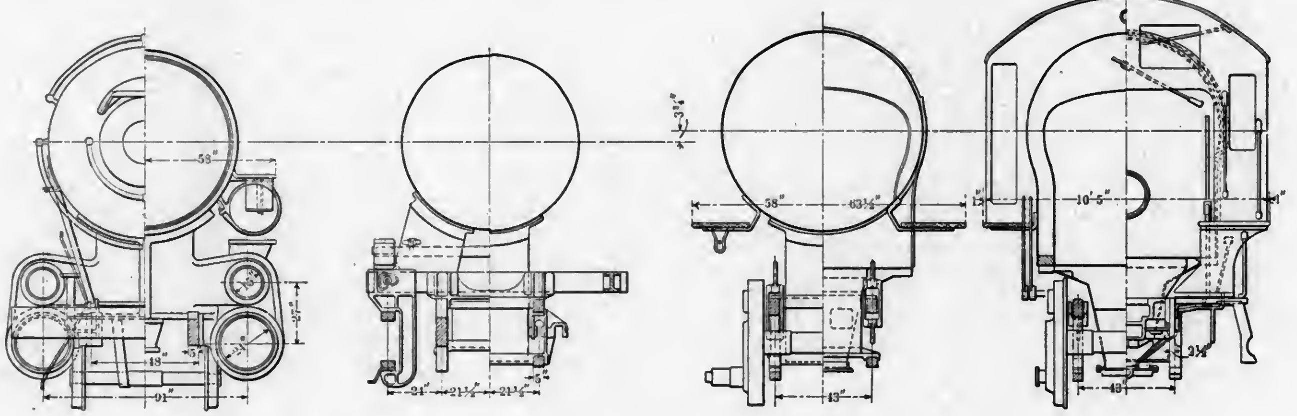
A FLUX FOR USE IN BRAZING CAST IRON can be made by mixing 1 lb. of boric acid, 4 oz. of pulverized chlorate of potash, and 3 oz. of carbonate of iron. To make a good brazed joint, the metal should be carefully cleaned and the pieces heated to a bright red before applying the flux.

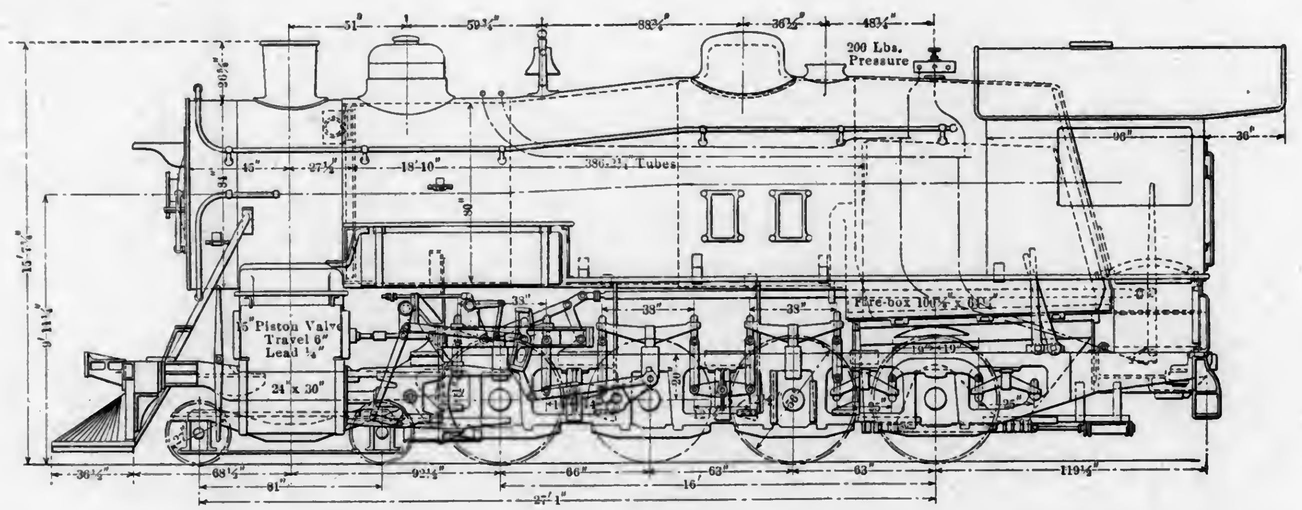
4-8-0 Type Locomotives for the Norfolk & Western Railway

AFTER FOUR YEARS' EXPERIENCE WITH A LARGE NUMBER OF 4-8-0 TYPE LOCOMOTIVES BUILT BY THE BALDWIN LOCOMOTIVE WORKS, THE NORFOLK & WESTERN RAILWAY HAVE ORDERED FIFTY MORE OF THE SAME TYPE FROM THESE WORKS, THE NEW ONES, HOWEVER, BEING CONSIDERABLY MORE POWERFUL.

In 1906 and 1907 one hundred locomotives of the 12-wheeled type were put into service by the Norfolk and Western Railway and have been eminently successful in handling heavy freight traffic. These locomotives were very fully illustrated and described on page 443 of the November, 1907, issue of this journal. Recently, as a further addition to the motive power, the company purchased fifty more of the same type, which have since been put into service and are giving very successful results, as is indicated by the data obtained from recent tests, mentioned later.

As compared with the earlier order, known as Class M-1, the new locomotives, or Class M-2, have the same diameter driving wheels and the same steam pressure. They also have practically the same grate area. The cylinders, however, have been increased from 21 x 30 in. to 24 x 30 in., and the boiler has been

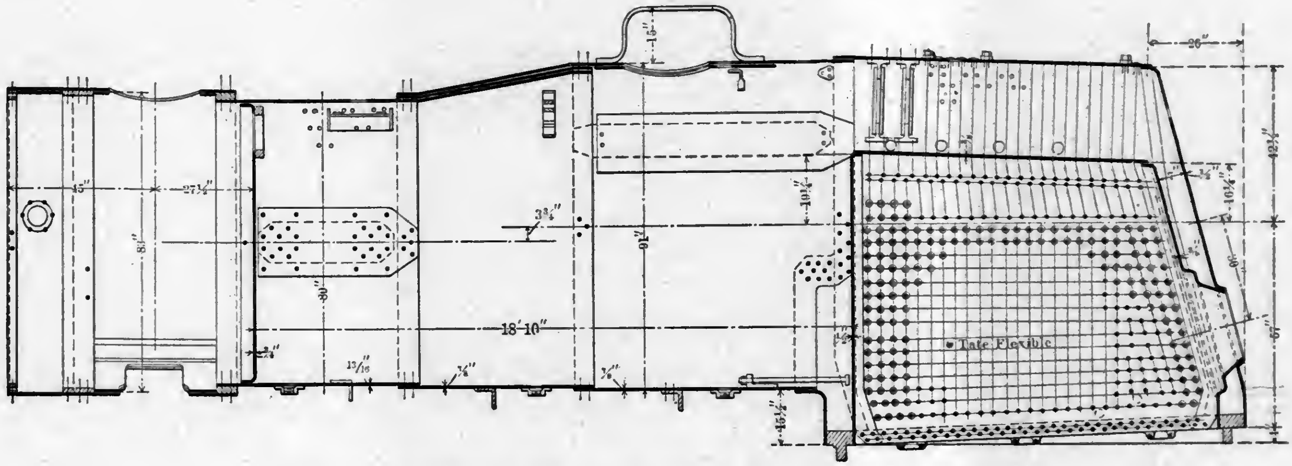




enlarged to be in practically the same ratio, with the exception of the grate area. The weight on drivers has been increased from 165,850 lbs. to 213,200 lbs., and the total weight by over 57,000 lbs. The theoretical tractive effort has jumped from 40,000 to 52,300 lbs.

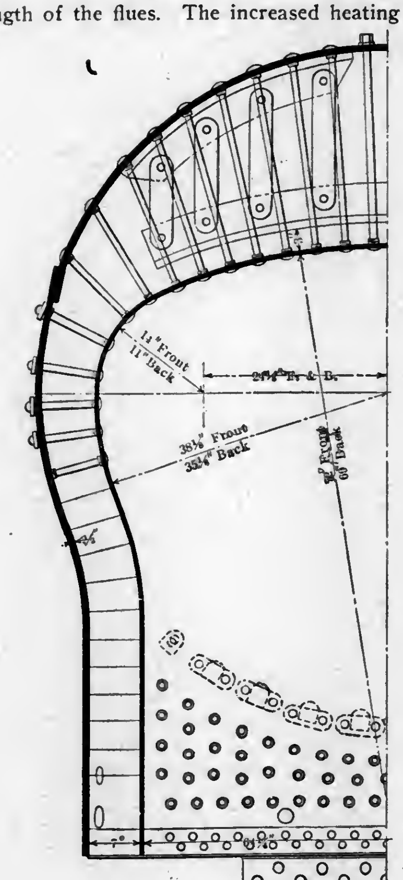
This new design has been prepared by the motive power department of the railroad and was built under the inspection of the mechanical engineer, and, of course, is based on the service of the previous locomotives. A comparative study of the two designs will indicate that the increase in power desired has been obtained by a practically corresponding increase in the size of cylinders and of the boiler. The ratio of total heating surface to volume of cylinders only being increased from 230 to 260. The grate area was left practically the same as before, as were also the length of the flues. The increased heating surface has been obtained by a 10 in. increase in the diameter of the boiler and about a 60 per cent. increase in the number of flues. Of course the related features, such as diameter of piston valves, size of frame, and all other parts, have been redesigned to suit, but few changes have been found desirable in the general arrangement.

Possibly the most noticeable change of this kind is seen in the use of the single front rail under the cylinders and a cast steel deck plate instead of the double rail and usual bracing, which was used on the Class M-1. New types of pedestal binders are also introduced, the thimble design being replaced with the forged strap binders held in place by three 1¼ in. bolts at each end. The valve gear has also been changed to use outside longitudinal bearers, as is shown in the illustration. Other details that have been redesigned will be noticed in the shape of the cab, the location of the air drums, which are now underneath the running boards instead of between the frames, and in more substantial frame bracing. A change to the slabbed section rear frame with a heavy cast steel foot plate extending further back from the boiler head is also noticed.



VERY LARGE BOILER ON NEW NORFOLK AND WESTERN 4-8-0 TYPE LOCOMOTIVES.

It is in the boiler, however, that the point of greatest interest is found in this design and the novel features of this consists of a wide fire box, which has side water legs arranged on the ogee curve and 7 in. width of mud ring all around the fire box. The boiler is of the extended wagon top design, measures 80 in diameter in front and 91 in. at the dome course. A front flue sheet of unusual thickness, viz., ¾ in., is noticed; the dome is flanged from a single steel plate also ¾ in. thick. A ¾ in. liner is used for reinforcing the sextuple riveted longitudinal seams, these joints being welded at each end. The fire box is of the radial stay design with a vertical throat and sloping back head. The mud ring is cast steel. The fire door opening is 18 in. in diameter and formed by flanging both sheets outward and riveting them directly together, this construction being the same as was used on the earlier design. In this case, however, the unusual width of water space made it necessary to form the inside fire box sheet with a flat annular space, reducing the width of the water leg immediately around the door to 4 in.



SECTION OF FIREBOX.

Flexible stays to the number of 477 are found in the boiler, being used to stay the entire throat sheet, the outside rows on the back head and in the breakage zone of the side sheet, as is shown in the boiler elevation. The grate is of the rocking type with bars extending entirely across the box, being arranged to shake in two sections, front and rear.

The shape of the side water legs is necessitated by the use of a somewhat narrower grate than would customarily be employed in a boiler of this diameter. It will be remembered that a couple of years ago C. A. Seley advanced the theory that the ogee side sheet in a narrow fire box boiler was responsible to a large extent for the fewer fire box failures which occurred in

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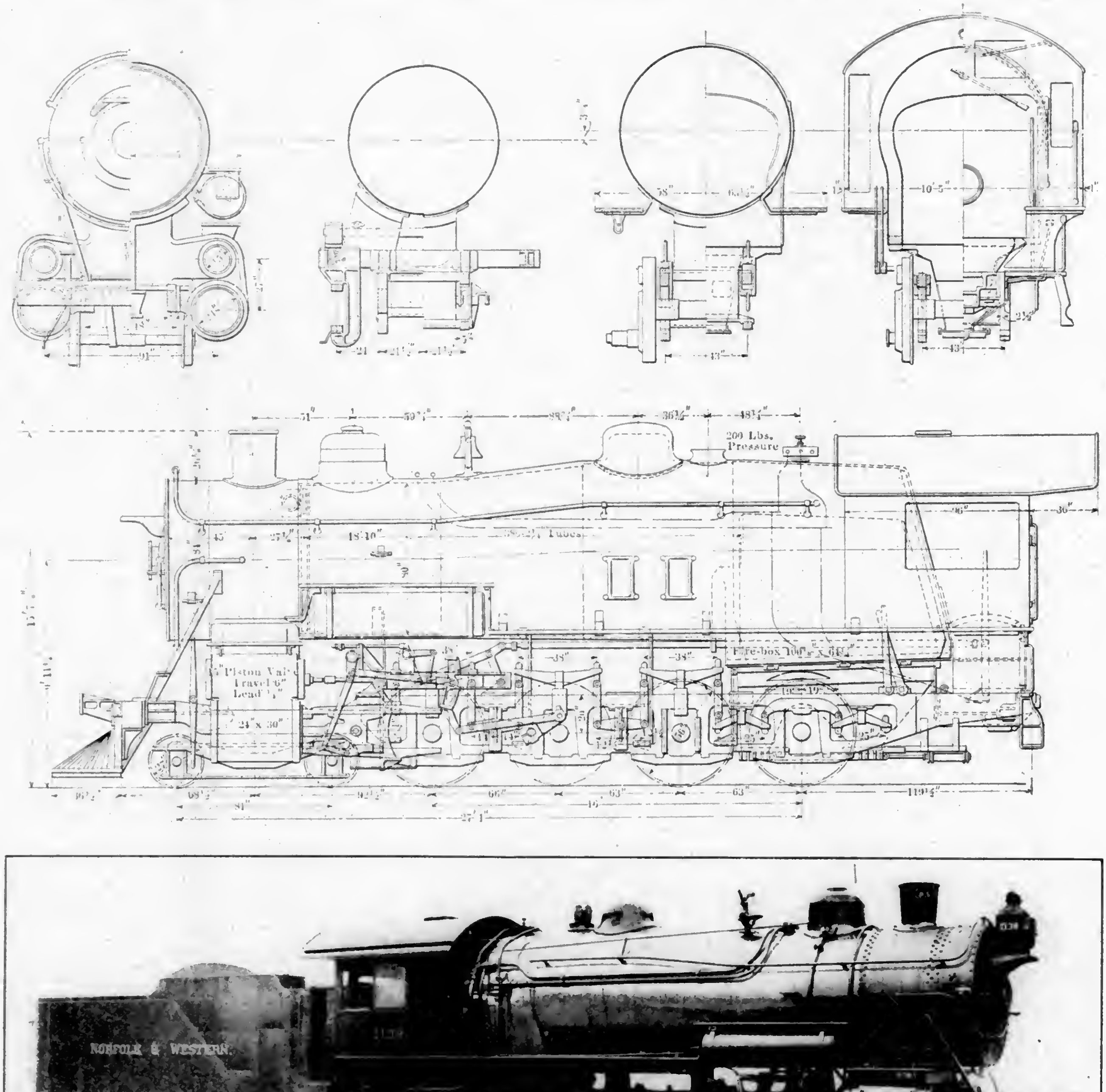

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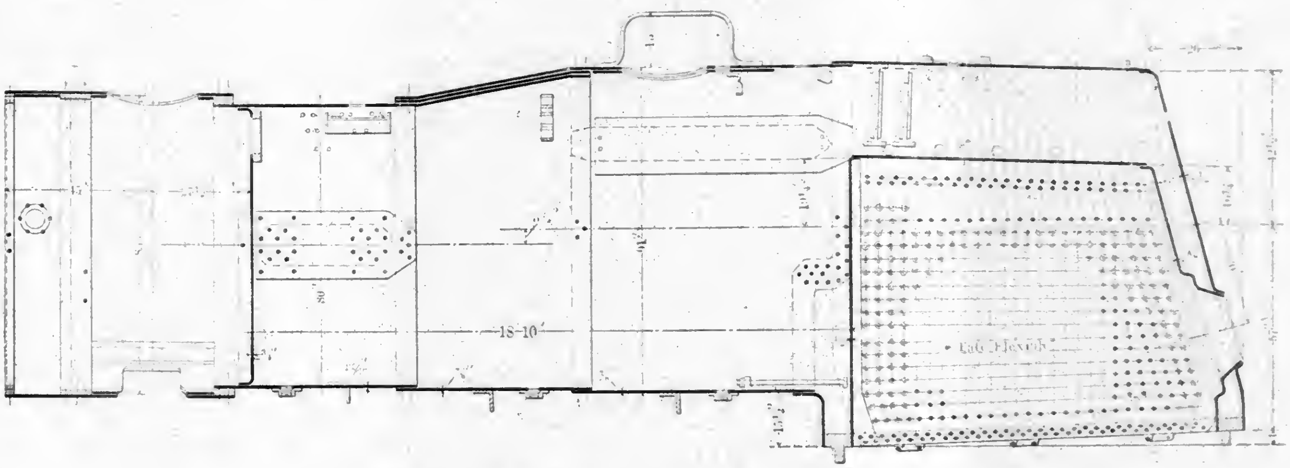

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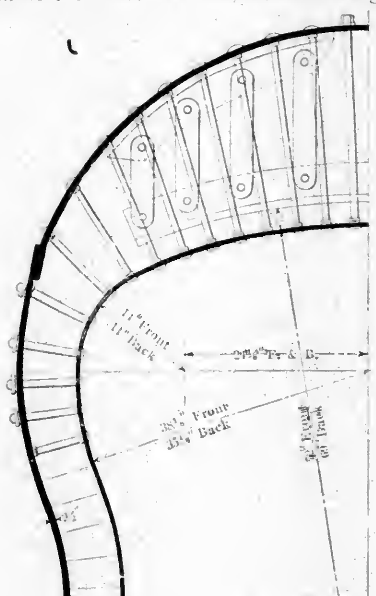


SECTION OF FIREBOX.

the earlier times. This theory seemed to be most reasonable and it would appear to be good practice, where possible, as it was in this case, to obtain the grate area desired without excessive length and still maintain the old shaped water leg. It will be noticed that the side and crown sheets are in one piece, although the outside wrapper sheet is in three sections. This same construction was used on the Class M-1, although there the water legs were vertical and not as wide.

Tests.

Recently one of these locomotives, No. 1124, was put under test between Roanoke and Christiansburg, and the result on the grade forming the last 29.7 miles, is shown in the accompanying illustration, wherein the various readings taken are presented graphically. The train consisted of 16 cars, including the dynamometer car and caboose, and weighed behind the tender 1,046.9 tons. In addition there was 215 tons weight of engine and tender. The total running time was 2 hrs. and 15 min. This includes at least two stops. This section of this road between Elliston and Christiansburg is on a steady up grade averaging 1.32 per cent. The following data, however, is the average for the total run from Roanoke:

COAL CONSUMPTION.

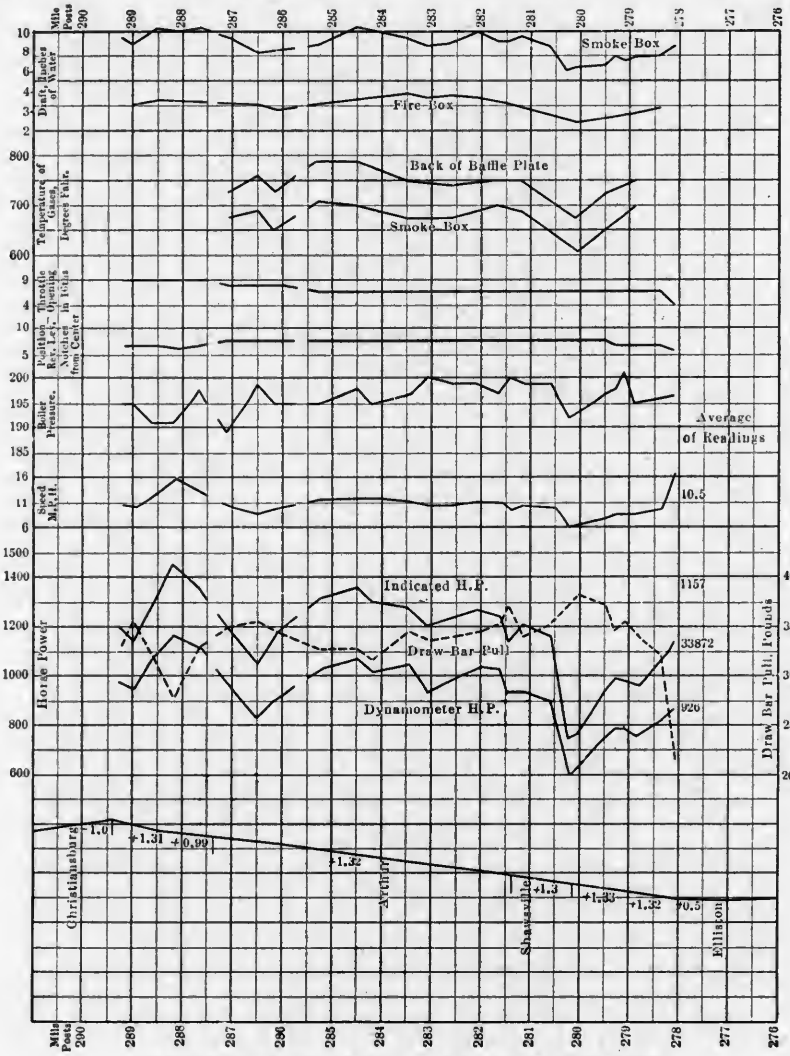
Total lbs. (excluding delays)	13,000
Per sq. ft. grate per hour	128.4

WATER CONSUMPTION.

Total lbs. evaporated	73,100
Equivalent lbs. evaporated	88,889
Equivalent evaporation per lb. of coal	6.84
Equivalent evaporation per sq. ft. heating surface per hour (excluding delays)	8.87
Boiler efficiency, per cent	55.3

The draft in inches of water was 7.68 in the smoke box and 3.2 in the fire box. The temperature of the gases in the front end was 732.4 degs. back of the baffle plate and 663.1 degs. ahead of the baffle plate. The steam showed an average quality of 98.9 per cent.

It will be seen that between Elliston and Christiansburg the average draw bar pull was but 33.872 lbs. and the indicated horsepower was 1,157. The dynamometer horsepower was an average of 926, making 231 horsepower absorbed in pulling the locomotive and its tender up the grade and in overcoming internal engine resistance. Of course, this record is for less than half the total distance and it is not possible to make any investigations in connection with the coal and water consumption as compared with the draw bar pull from the data at hand. The boiler efficiency is very fair.



GRAPHICAL RECORD OF TEST OF 4-8-0 TYPE LOCOMOTIVE.

The general dimensions, weights and ratios of the Class M-2 locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	52,300 lbs.
Weight in working order	261,100 lbs.
Weight on drivers	213,200 lbs.
Weight on leading truck	47,900 lbs.
Weight of engine and tender in working order	430,000 lbs.
Wheel base, driving	16 ft.
Wheel base, total	27 ft. 1 in.
Wheel base, engine and tender	62 ft.

RATIOS.

Weight on drivers ÷ tractive effort	4.08
Total weight ÷ tractive effort	4.99
Tractive effort × diam. drivers ÷ heating surface	714.00
Total heating surface ÷ grate area	91.80
Firebox heating surface ÷ total heating surface, %	4.43
Weight on drivers ÷ total heating surface	51.80
Total weight ÷ total heating surface	63.60
Volume both cylinders, cu. ft.	15.80
Total heating surface ÷ vol. cylinders	260.00
Grate area ÷ vol. cylinders	2,83

CYLINDERS.

Kind	Simple
Diameter and stroke	24 x 30

VALVES.

Kind	Piston
Diameter	15 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10½ x 12 in.
Engine truck wheels, diameter	27 in.
Engine truck, journals	6½ x 10 in.

BOILER.

Style	Wagon top
Working pressure	200 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	100⅛ x 64¼ in.
Firebox plates, thickness	⅜ x ½ in.
Firebox, water space	7 in.
Tubes, number and outside diameter	386—2¼ in.
Tubes, length	18 ft. 10 in.
Tubes, material	Steel
Heating surface, tubes	3,922 sq. ft.
Heating surface, firebox	182 sq. ft.
Heating surface, total	4,104 sq. ft.
Grate area	44.7 sq. ft.

TENDER.

Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

ANNUAL PASSES TO BE REDUCED.—Commencing January 1 next, the issuance of annual complimentary passes by Western railroads to representatives of other roads below the rank of either general assistant passenger agent or assistant general freight agent is to cease. This action has been made possible by the decision of executive officers of the railroads that freight departments be brought under the same restrictions in this respect as passenger departments.

EDUCATION AND THE DEVELOPMENT OF THE APPRENTICE*

Under the present educational system the conditions are indeed rare where the American boy receives any encouragement to enter the industries, either in the home or school. In most cases the parental influence is either absolutely wanting, or it is against any form of manual work; on the other hand, the teacher often lacks sympathy and is indifferent to a boy's pursuits, especially if he is not strong intellectually.

What we need are well planned industrial courses, in charge of broad-minded men who will awaken and develop the home influence and give increased value to the dignity of labor.

Following somewhat the recommendations of Dr. J. P. Haney (Director of Manual Training in New York), I would urge that manual training be taught in all the elementary schools, and that at the end of the 6th grade, corresponding to the age of 12 or 13 years, separate elective courses be established; the one, as at present arranged for professional and commercial training, as well as the higher technical training, leading to and through the high school; the other having in view the industrial training of the pupil. Bearing in mind the class of boys it is desired to interest and develop, and the object to be attained, practical work should predominate, but during the 7th and 8th grades, that is, the first two years, the training should be general, with a view to increasing the versatility of the boy rather than his specific training during these years. In order to keep the boy busy, inasmuch as there would be less preparation of studies, it would seem desirable to require that 6 or 7 hours a day be spent in the school, of which time at least one-half should be devoted to industrial work under skilled workmen; the rest of the time could be divided between such subjects as drawing and the study of industrial geography, history, English and arithmetic; this latter should contain plenty of practical problems of interest to the pupils. There should also be shop talks relating to the various industries.

Two additional years would follow this industrial-preparatory, and these should be trade-preparatory, in which the time spent is devoted to some one definite trade, to the end that by judicious and intelligent training the boy may enter some industry where he will be given an opportunity, at fair wages, under an apprentice instructor to finish the trade begun in the trade preparatory school. In this school, which a boy enters at 14 or 15 years of age, the time could well be increased to 8 hours a day, with 4 hours on Saturday, and there seems no good reason why the practical work should not be continued for eleven months of the year. The amount of time spent in practise would vary somewhat, but in general in most trades 4 hours a day could be devoted to shop work and the remaining 4 hours divided between drawing and other studies, more or less related to the specified trade. During the course history and civil government, English, arithmetic, practical geometry and physics should be given some attention. An important feature of this course would be the co-operation of an advisory committee suggested by Mr. Higgins. This would materially assist in co-ordinating the work of the school with that of the various industries, and it is not at all improbable that in many localities satisfactory arrangements could be made by which the more advanced pupils might, under proper instruction and suitable wage conditions, be employed on commercial work for local firms. This would greatly increase the interest and would furnish a stimulus for speedy work usually lacking in school shops.

The amount of time required to finish a trade would be reduced very materially under such a plan, and it is safe to say that the hopes of early reward would encourage many a boy to hold out and complete the entire school course instead of quitting as at present. It is not to be expected that all such boys would become skilled tradesmen; but it must be conceded that the training could well be adapted to prepare all boys who might desire to enter industrial pursuits and by a process of selection and elimination, those best qualified by natural endowment and otherwise, could be trained as all-around men for the trades, while others, who did not give such promise of development, would be trained for some special work, as for instance, machine molding, in the foundry or machine hand in other industries.

It is recognized that no universal system of trade education will be generally applicable to every community; local conditions will suggest and demand modifications; and we should expect in certain localities to find emphasis laid on the teaching of trades required in the industries which predominate in the vicinity.

In working out the course of study for such industrial education it should be constantly borne in mind that some of the boys who enter upon industrial training will reach a time in their lives when they will want to keep on with their studies and enter a technical college. Provision for such boys must be made by a modification of the high school courses with this in view, and if necessary, the college entrance requirements should be changed.

It is admitted that the expense in equipment and maintenance of such departments in our public school systems would be considerably greater than that now incurred, but it is submitted that the cost is a matter of lesser import than the results. Attractive industrial departments manned by enthusiastic, capable, properly paid teachers would cause a greater number of pupils to remain in the schools for a longer period, and the intellectual development, coupled with the training in discipline received by the additional thousands of school children all over the country would in itself be an economic advantage. Moreover, if the introduction of such departments would afford better preparation for the industries and reduce the idle or waste years of a boy, the productive gain and increase in wealth in a given community would more than warrant any reasonable additional cost.

On the other hand, the expense involved on account of "repeaters" would be greatly diminished and the amount thus saved would materially assist in maintaining industrial schools.

It is also submitted that the hopes and ambitions of a boy, the habits of industry, the definiteness of purpose in life, inspired by contact with real things: all make for a higher uplift which will result in the social betterment of the people and its attendant lessening of crime fostered by idleness.

* Conclusions of a paper by Prof. J. J. Flather read before the National Founders' Association.

THE PRICE OF RADIUM.—Sir William Ramsey stated recently that the cost of radium was now $2,100,000 per ounce, which is slightly less than a year ago, when, in an address at the laying of the cornerstone of the radium factory at Limehouse, he said that the value of the substance was $2,500,000 an ounce, which was at the rate of $90 per milligramme. In January last the price was said to be $3,000,000 an ounce. About a year ago there was only a quarter of a pound of radium in the whole world, and the quantity is not much greater at the present time; in fact, literally pure radium only dates from September 5 last, when Mme. Curie told the Academy of Sciences in Paris that she had at last succeeded in obtaining pure radium. For some time past a radium bank has existed in Paris, and last January one was established in London, and similar institutions are to be founded in other great cities. These banks loan the precious substance to scientists and physicians. The cost is enormous, as much as $200 being charged for the use of 100 milligrammes for a single day.

THE NEW PENNSYLVANIA LOCOMOTIVES which have recently been placed in service on the New York City electrification of the Pennsylvania Railroad, are to be operated under the supervision of "instructors" familiar with the details of construction of these machines. Men from the engineering apprenticeship course, who have been connected with the railway department of the Electric Company at East Pittsburgh during the construction of the locomotives in the shop and the subsequent operating tests have been sent to New York as instructors.

Standard Locomotive Maintenance Practices

INTERESTING RETURNS FROM SEVERAL PROMINENT RAILROADS INDICATE THE IMPORTANCE OF STANDARDIZATION IN DEFINING LIMITS OF WEAR.

There are certain time-honored features of deterioraton in locomotives generally which through their familiarity to all interested have become what may easily be called examples of standard wear. For instance, it is inevitable that the cylinders at some time must become enlarged to a point where a return must be made to their original diameter; crank pins and axles will be so far reduced below their normal size that they must be renewed; driving box brasses are likewise susceptible, and so on through many other of the component parts. This is the result of wear arising from service which cannot be evaded, and the combat of which constitutes the problem which must be solved before the economical and efficient working of the loco motive can be secured.

Since the various features which require maintenance operations are so generally understood, and in fact anticipated, it would appear that uniformity would be in evidence in defining the permissible limits of wear, but singularly enough there is a wide range of latitude in interpreting the requirements of the latter. It may be said that between various railroads entire agreement exists only in connection with two or three repair items in regard to wear limits, and that in the large majority considerable difference of opinion is in evidence. For this reason it is quite difficult, if not impossible, to compare to any value the cost of repairs between one railroad and another. The elasticity of the subject, as evidenced by these different views, affords an interesting illustration of the high factors of strength and safety which have become so identified with the American locomotive.

In the tabulated returns from ten prominent railroads herewith, the more common items are enumerated, and against each item, under an initial letter representing a separate road, is set the practice of that road in the conduct of the operation indicated. It will be noted that some of the roads interrogated returned no information in the instance of several items in the list; in fact, with the exception of roads "A" and "D," the returns are far from complete, and in cases where these omissions are plentiful it may be safely taken to imply that the road in question has not yet standardized its wear limit renewals. This information is of particular value in itself as indicative, at a glance, of the present status of the standardization of locomotive maintenance practices on ten of the most prominent railroads in the country.

In the table, which will well repay a study, principal interest centers in a comparison of the different views entertained by the various motive power managements in their treatment of the features of wear on which they were questioned. The last column illustrates the greatest difference in opinion between the ten roads.

It will be noted that 3/32 in. practically represents the average opinion in regard to cylinder wear before reboring. The roads which did not return on this item leave it to the discretion of their local shop management, and this applies to all other items where figures are not shown. This 3/32 in. limit represents a very good practice, as 1/16 in., which is the imperative reboring limit on road "A," is scarcely consistent. It is believed that the insistance on reboring with this amount of wear would result in an unwarrantable loss of time and money, because few cylinders, especially on heavy power, are not worn at least that much.

Experience has shown that a cylinder with its bore in what is called an "enameled" condition, has attained an ideal state, and it would be rather unfortunate to turn off this smooth brown oil permeated surface for a variation of 1/16 in. in the diameter of the bore. There is also the likely chance that in the reboring operation the cylinder will be left as badly if not worse out of round than it was before, and minus the brown surface. A recent calipering of one hundred new cylinders showed eighty-seven to be out of round at least 1/16 in., so this is a standard practice which might be left to the shop to perform when considered necessary. Of course, it is based on the idea of saving fuel and returning the engine to as good a condition as it was at first, but the insistance on it is not advisable from what has been said.

Road "A" does not also follow the best practice in its countenancing cylinder bushings with a minimum thickness of ¼ in. The other three roads reporting on this item all assign ⅝ in. as the minimum, and this experience has shown conclusively to be the lightest stock which can be employed without danger of breakage or difficulty in application. In the case of the ¼ in. bushing there is another objection in the fact that it must be closely watched in service and calipered frequently to see that it does not wear to a point where it may give away and cause a damage to the piston or cylinder proper. The majority of the roads agree that the cylinder should first be heated, the expansion thus permitting the bushing to be slipped in, or lightly tapped into position. Only one road advocated drawing the bushing in cold, assigning as a reason that being in contact with the steam its expansion under the heat therefrom would serve to hold it. A bushing extending entirely through the cylinder, with a bearing on both front and back heads, seems to be generally favored as the best practice in this regard.

Road "B" allows piston valve bushings to reach ¼ in. above nominal diameter before renewal, but road "A" in its practice is more consistent, making ⅛ in. the limit. It is a well-known fact that the breakage of piston valve rings is much more frequent in instances where undue clearance exists between the valve and the bushing. Road "D" assigns 7/32 in. as the limit and the others are non-committal, with the exception that all have the bushings renewed on each occasion of heavy repairs to the engine.

Six roads depend on their shops for the renewal of piston heads when worn below the cylinder diameter, and only four roads assign a limit of wear. In the case of road "A" its 1/16 in. is no less than preposterous and it is safe to say that there is not a piston head on that road without a greater clearance than this condemning limit. The idea, of course, is correct beyond dispute in the saving of packing rings, better alignment of reciprocating parts, and more uniform cylinder wear, but it is an example of straining after an impossible ideal in railroad service.

Piston heads can be safely and judiciously allowed to run ⅛ in. below cylinder diameter without appreciable bad results, and in many instances, which have been noted, no ill effect resulted from a much greater wear than this. When it is considered that locomotive maintenance practices are probably more thoroughly standardized on road "A" than any other in the country the effect of this ill-advised 1/16 in. limit of piston head and cylinder bore wear can possibly be appreciated. Furthermore, the various limits are absolutely insisted on and much delay must necessarily ensue through unavailing renewals. It is for this and other reasons that the utmost care should be exercised to evolve common sense standards, and these should have the preliminary approval of all master mechanics interested before becoming the law. It is safe to say that no master mechanic, whether or not of road "A," could find much in justification of this renewal, except the ideal conditions which have been before mentioned as largely unattainable.

In the matter of piston rods there is a rather close approximation between the various roads, an average of about 3/16 in.

CONDEMNING LIMIT OF WEAR FOR VARIOUS LOCOMOTIVE PARTS ON ROADS DESIGNATED "A" TO "J."

Standardized Operations.	A	B	C	D	E	F	G	H	I	J	Opinion differs.
Cylinders to be rebored (when out of round)	2-32″		3-32″			3-32″				3-32″	1-32″
Cylinders to be bushed (when worn)	10-16″	7-16″	12-16″	6-16″	8-16″		12-16″	8-16″		12-16″	5-16″
Minimum thickness of bushing	4-16″	10-16″			10-16″		10-16″				6-16″
Minimum thickness of cylinder wall		12-16″			10-16″		10-16″				2-16″
Piston valve bushings to be renewed (when worn)	4-32″	8-32″		7-32″							4-32″
Piston heads (when worn below cylinder diameter)	2-32″		6-32″	3-32″		4-32″					4-32″
Piston rods (when worn below original diameter)	2-16″	3-16″	3-16″	3-16″	4-16″	4-16″	3-16″	3-16″		4-16″	2-16″
Valve stem (" " " " ")	2-16″			3-16″	2-16″						1-16″
Slide valve flanges (minimum thickness)	10-16″		8-16″	10-16″	10-16″			6-16″			4-16″
Minimum height of valve seat (before applying false seat)								7-16″		7-16″	
Side rod bushings (when worn above pin)				1-16″							
Crank pins (when worn below original diameter)	8-32″	6-32″		10-32″	8-32″	3-32″	8-32″	12-32″		when 5 years old.	9-32″
Driving box brasses (minimum thickness in crown)	1⅜″	1⅛″									2-8″
Driving axles (when worn below original diameter)	½″	⅜″		⅜″	½″	½″	⅜″	½″	½″	½″	1-8″
Engine truck axles (when worn below original diameter)	¼″	⅜″		¼″					¼″		1-8″
Tender truck axles (" " " " ")	¼″	¼″		¼″					¼″		

reduction in the original diameter being the condemning limit. These limits given in every case are irrespective of the original diameter of the rod, and apply equally to one of 2½ in. and to one of 4 in. There is nothing to criticise in these practices as a reduction of 3/16 in. in a piston rod naturally implies an age where metal fatigue or crystallization becomes in order, and it is a good precautionary measure to remove, anneal and rework them thoroughly before turning down for use in engines carrying smaller diameter rods.

No limit is set, with one exception, on the wear of side rod bushings, and, in this, road "D" is working to a refinement quite hard to secure as its condemning limit of 1/16 in. is generally present on freight engines in a week and passenger power in a month. Unless the care of the driving box wedges is far more to the point than is exercised on the majority of American railroads the maintenance of side rod bushings as desired by this road becomes a matter of sheer impossibility. On the presumption that standard practices once promulgated are insisted on, it would be well to discard this one, and try to attain the end by work underneath the engine. Otherwise the roundhouse floor will be bestrewn with rods on all occasions, and much serviceable power will be idle.

Driving and truck axles do not show much variance in the views entertained, no doubt arising from the fact that these parts are more generally discussed than others and certain general limitations in dimensions have been adopted to govern them, but it will be noted that there is a difference of opinion of 9/32 in. in regard to crank pins. Road "H" allows a reduction of ⅜ in. from the original diameter before renewal. This is so very much greater than the next nearest, ¼ in., which is the limit on three other roads, that no conclusion can be reached but that the pins on road "H" are of excessively heavy and unwarranted stock.

Driving box brasses are not commented on in this connection except by roads "A" and "B," and both of these allow too low a minimum of thickness in the crown before renewal; that is, 1⅜ in. and 1⅛ in., respectively. There can be no question among those who have intelligently followed this detail but that 1½ in. is the lowest permissible thickness which any driving box brass should be allowed to run. It is unfortunately a common practice, which a walk through any shop will substantiate, to rebore these on the occasion of general repairs until they "clean up," and irrespective of what thickness the remaining metal may have. This would very likely be in evidence on the eight roads not reporting on this item as they do not have instructions governing the procedure in relation to this part.

This interesting question of standardizing maintenance practices has been presented merely as illustrative of the views entertained by widely separate roads in consideration of the same subject, but it becomes more vital when confined to a single road. Only during a comparatively recent time has the matter been given attention, except in a desultory fashion, but it is now quite evident from the replies received from various roads that it is being vigorously attacked in many quarters and endowed with the importance which it deserves.

The plan which is now being followed with much success in at least two instances is to print the various repair operations and wear limits on standard card forms which are distributed among the master mechanics, general foremen and possibly the gang foremen, but at all events they are accessible wherever required. Before sending these out, however, as standard operation, they have a preliminary circulation, as blue prints, among those interested, who are free to criticise as they please. Not until all the criticisms are returned and the proposed card revised as may be necessary does the practice become standard. Only the more common operations should be standardized, and the matter must be proceeded with cautiously, but it is worth the experiment in the certainty of results and above all in the circulation of the most economical and labor-saving ways of doing work.

THE WORLD'S LARGEST ELECTRIC CLOCK.—An electric clock which is claimed to be the largest in existence has been constructed by Messrs. Gent & Co., Limited, of Leicester, for the new buildings of the Royal Liver Friendly Society, Liverpool. It has four dials, and is to be erected in a position 220 ft. above the ground. The hands are made of copper, and those for the minutes, measuring 14 ft. long by 3 ft. wide at their broadest part, have been specially strengthened with a 9 in. gun metal backbone. The opal faces have been built to withstand a wind pressure of over 11 tons. The outer circle of the dials, which are 25 ft. in diameter, is made up of 12 sections, each measuring 6 ft. 3 in. by 5 ft. 6 in., and weighing 5½ cwt. The total weight of the framework of each dial is 3½ tons. The dials will be electrically illuminated, and the current will be switched on and off automatically at dusk and dawn.

NEW UNION STATION IN CHICAGO.—Work on the construction of a new passenger station in Chicago on the site of the present Union Depot will begin early next spring, and will be pushed to completion with all possible rapidity. The building itself will cost $5,000,000, and the outlay for the purchase of the land needed will bring the total investment up to $20,000,000. Negotiations relative to the project, which have been in progress for a long time, have now reached a point where the five railroad systems interested are prepared to make application within sixty days for a permit to begin building operations. Darius Miller, president of the Chicago, Burlington and Quincy Railroad, has declared that the erection of a new depot is assured.

AUTOMATIC GATE REGISTER.—The Pennsylvania Railroad is said to be considering the installation at Union Station, Pittsburg, of an ingenious device for registering automatically the number of passengers passing through the trainshed gates. The apparatus comprises a stream of compressed air which plays continuously across the passageway and holds open a circuit, except when it is interrupted by the body of the person traversing the passageway. These interruptions register the number of persons passing.

PNEUMATIC RIVETER FOR COUPLER YOKES

NEW YORK, NEW HAVEN & HARTFORD R. R.

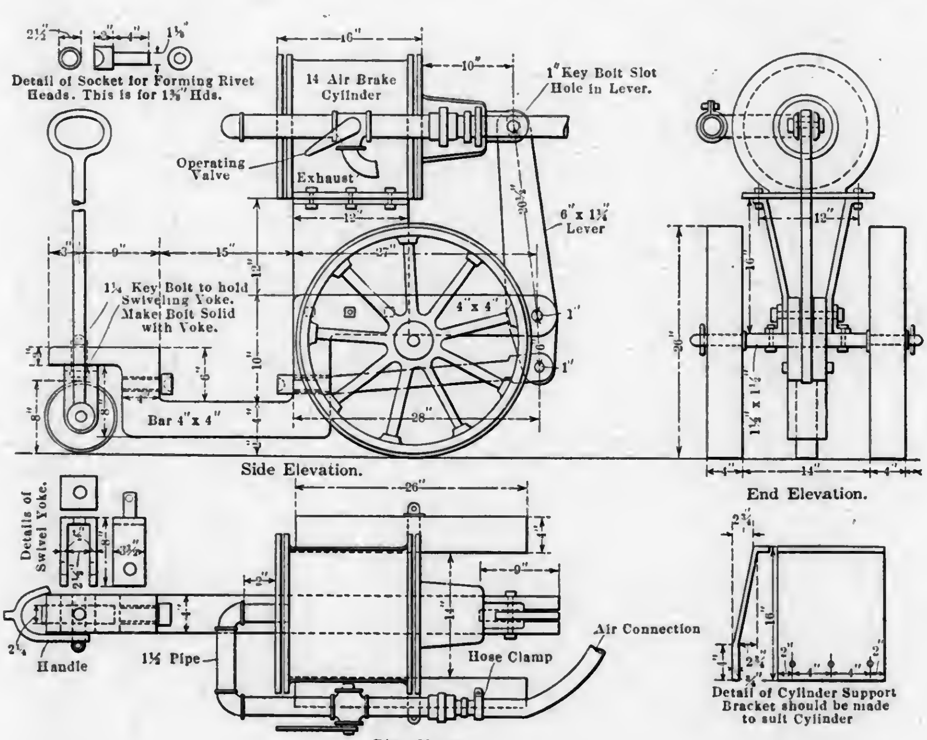
The coupler repair problem is not by any means the least important in car shop work. On a road having say 20,000 cars, it amounts on an average to some 3,000 couplers in a year. Of this 75 per cent. are removed due to the failure of the coupler proper, and generally resulting from accident. The coupler yoke is only found defective to the extent of about 25 per cent., but in all cases the parts must necessarily be stripped and reassembled after whatever renewal has been made.

In line with the progressiveness which is so characteristic of car repair work on the New York, New Haven & Hartford Railroad, this particular item has been the subject of much attention at the Readville shops of that company, and through careful attention to working out all details the minimum has been obtained in both items of time and cost. One day in each week, generally Friday or Saturday, is found amply sufficient to clean up the previous six days' accumulation of broken couplers from all points on the system and to place them in the Readville storehouse for redistribution on requisition. The entire labor cost is but 19 cents per coupler, including stripping, renewal of either yoke or coupler, riveting up, and for the necessary movement of the parts about the plant.

This very low cost is largely made possible through the pneumatic riveting machine, a home-made affair, which is herein shown. Its construction is very simple, as is clearly evident from the drawing and illustration. It will be noted that the arrangement of the frame is such that the coupler does not have to be lifted, as was formerly the case when the yoke rivets were headed under a steam hammer. All the labor required is to upend and drop it transversely across the depressed part of the riveter frame in line with the rivet socket, and the rivets are headed through the action of a 14-in. brake cylinder piston under 80 lbs. pressure, which is that of the shop air line, and in a single thrust.

The capacity of this very efficient tool is enormous, 200 couplers, varying from 2 to 3 rivets each, is considered as only a fair day's work for it. Two men perform the entire operation of temporarily bolting the yoke and coupler, heating and applying the rivets, handling the riveter and disposing of the coupler outside of the shop. In shops where much repair work of this description is done this cheap and adequate device will prove of the greatest value.

A SIMPLE AND EFFICIENT RIVETER.



DETAIL ARRANGEMENT OF PNEUMATIC RIVETER.

GETTING OUT A BROKEN TAP is considered a very hard job, and especially where the tap is small or in a finished piece of work that cannot be heated in order to anneal the tap. To make this task an easy one, pour muriatic acid into the hole. Leave it there for about four or five minutes and enough of the tap and the hole is eaten away to loosen the tap, which can then be backed out.

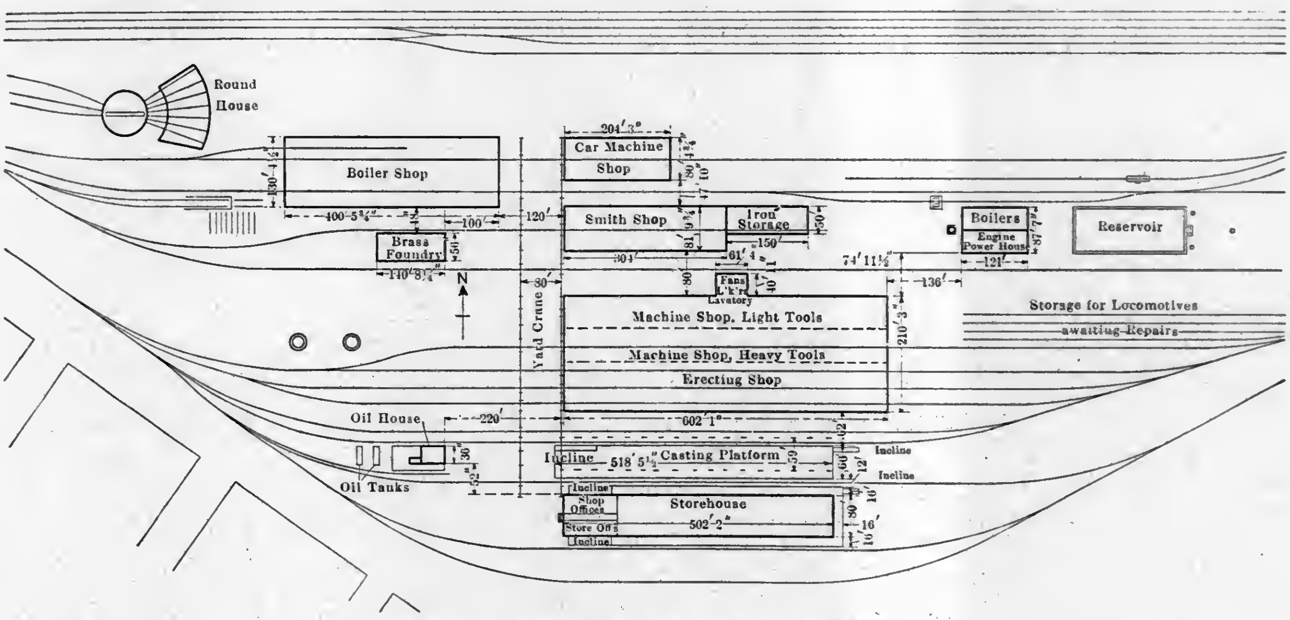
New Locomotive Repair Shops at Havelock, Neb.

THE OLD LOCOMOTIVE REPAIR SHOPS ON THE CHICAGO, BURLINGTON & QUINCY RAILROAD AT HAVELOCK, NEB., HAVE BEEN TRANSFORMED INTO PRACTICALLY A COMPLETE NEW PLANT BY THE ERECTION OF A NEW ERECTING AND MACHINE SHOP; A LARGE SYSTEM STORE HOUSE; A COMPLETE POWER HOUSE AND A SYSTEM OIL DISTRIBUTING STATION.

On the lines of the Burlington west of the Missouri River, the introduction of large Mallet locomotives, together with a large increase in the number and size of other locomotives, has brought about a condition which made it imperative to furnish decidedly more extensive and complete repair facilities than were provided by the shops which had served these lines in the past. These shops, howver, originally constructed in 1894, were in advance of their time in many features of general design and were in far too good condition to be razed, therefore the new shop plant was designed so as to make use of the present buildings in the following manner: The present machine and erecting shop has been replaced with an entirely new and thoroughly up-to-date structure, and the building now used for this work is changed over for boiler shop use. The present boiler shop is then to be made into a new forge shop and the present forge shop is to be changed into a car machine shop. Since in the new machine shop all of the tools will be electrically driven, most of them by individual motors, and also because a number of new cranes, elevators, increased forge shop equipment, etc., that will require a decided increase in power house capacity, the old power house was abandoned and transformed into a brass foundry and a complete new power house has been constructed. At the same time a new storehouse of exceptional capacity, which is to be a central distributing point for all the lines west of the Missouri River, has also been built. A large new oil house forms the fourth building of the new list.

The use of the old buildings for the purposes mentioned has made it impossible to obtain an ideal arrangement, so far as the inter-relation of the various buildings are concerned, but nevertheless by means of an 80 ft. traveling yard crane, which serves all of the buildings of the plant, most of the difficulties of inter-shop transportation have been solved and with the exception of a single feature of the necessity of transporting boilers out of the erecting shop under the yard crane then about 300 ft. by means of the yard crane and again in the boiler shop, there can be but little objection raised to the arrangement. When it is considered that a building provided with cranes and suited in every way for boiler shop work, is already in existence, it is easily seen that the expense and delay incident to this transportation of boilers is not sufficient to make it advisable to construct a new building for these repairs.

A study of the illustration will show that the yard crane is the main artery of the transportation system and that from it a connection can be made into all buildings with ease by means of the numerous tracks passing under it. A large extending platform, on which it is proposed to store the heavier parts, extends underneath the yard crane and is provided with a crane of its own, which also extends far enough underneath the yard crane runway to permit the transfer of heavy castings from one crane to another without difficulty.



GENERAL ARRANGEMENT OF NEW SHOPS AT HAVELOCK.

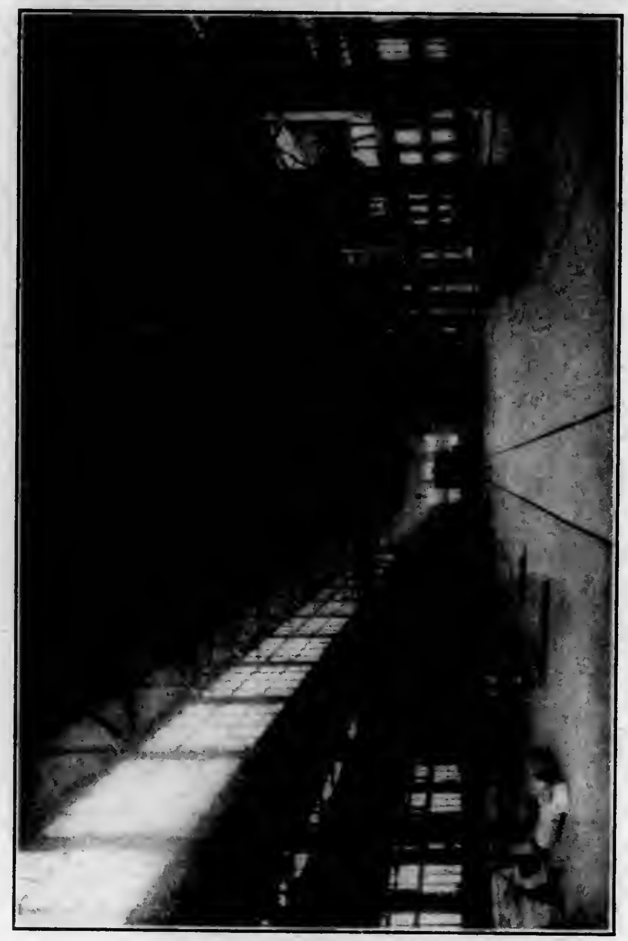
Some surprise may be occasioned by the location of the power house, but when it is considered that this is adjacent to the smith shop and the large machine shop, the two shops which require its output to the largest extent, and also that it was located with the idea of possible future extension in the nature of freight and passenger car repair shops, it will be seen that its location cannot be justly criticised.

Erecting and Machine Shop.

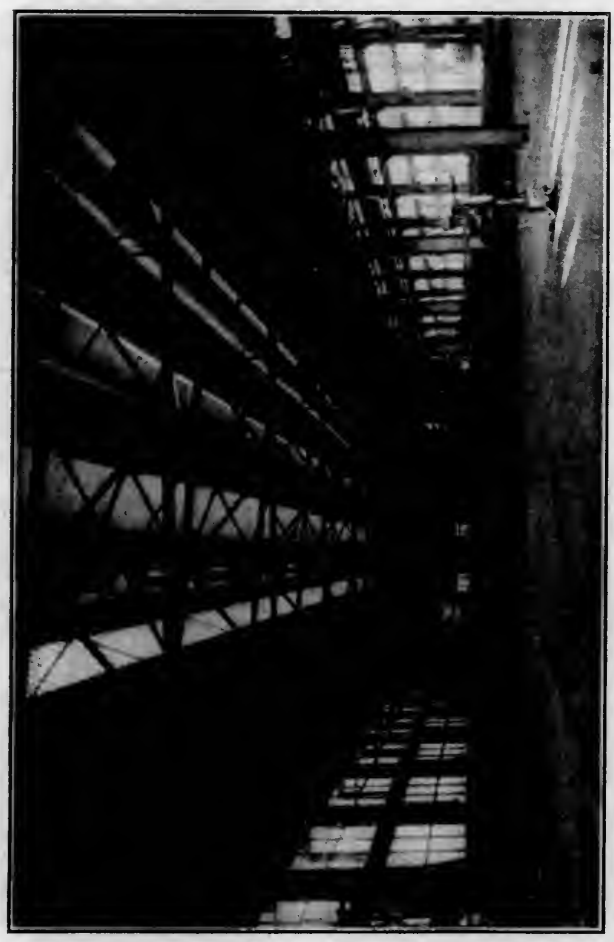
One of the illustrations shows the cross section of this very large building, which is devoted entirely to erecting shop and machine work. It is of the longitudinal type, three tracks running the entire length of the erecting shop, which occupies 90 ft. on one side of the building. Adjacent to this is a heavy machine bay 60 ft. in width, back of which is another 60 ft. bay for the lighter tools. The building is over 600 ft. in length.

Over the erecting shop there are two 4-motor girder cranes, each having a main hoist capacity of 75 tons and an auxiliary capacity of 15 tons. In addition to this over the outside tracks there are four, two on either side, 3-motor, 3-ton traveling wall cranes. Over the middle or heavy machine bay there is one 3-motor girder crane, having a capacity of 10 tons and a span of

ABOVE—GENERAL VIEW OF NEW BUILDINGS. BELOW—STOREHOUSE.



INTERIOR OF HEAVY MACHINE BAY.



INTERIOR OF LIGHT MACHINE BAY.

GENERAL VIEW OF ERECTING SHOP.

58 ft. As soon as the shop requirements indicate its necessity another crane of similar capacity will be installed on the same run-way. All cranes throughout the plant were built by Niles-Bement-Pond.

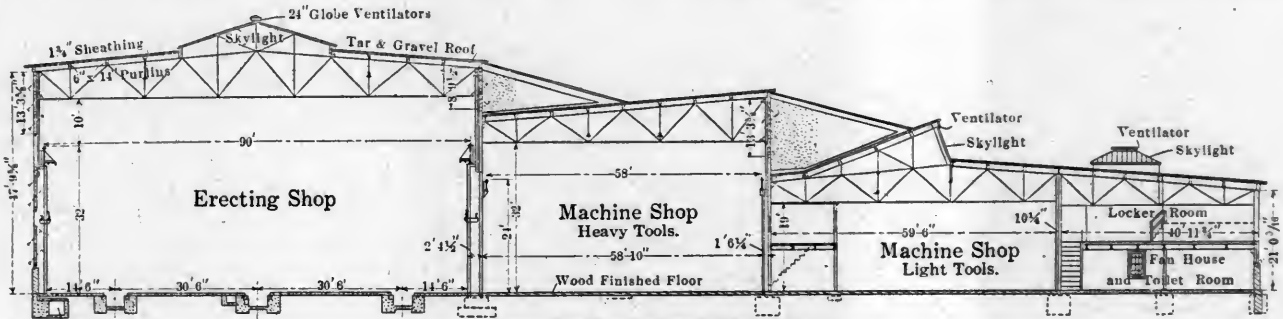
A very substantial steel construction forms the frame work of the building. The enclosing walls are constructed of 1 in. channel studding secured with iron straps to the steel girths and covered with galvanized expanded metal wired on. To the expanded metal is applied four coats or layers of cement plaster, each ¾ inch thick, making a wall of good weather resisting qualities and of sufficient thickness to embed the steel.

A concrete floor has been provided in the erecting shop, while in the machine bays the floor consists of a course of 3 in. Burnettized Oregon fir laid on tamped sand, the boards being nailed together. Over this sub-floor is laid a wearing surface of 1⅛ in. maple factory flooring. The roof of the building consists of 2 in. sheathing laid on 6 x 14 in. purlins and covered with 5-ply pitch felt and gravel laid according to the Barret specifications.

arrangement of the stored parts, it will prove sufficient. In some cases, as for instance at Readville, this question has been solved by storage pits below the floor. This scheme, however, requires two separate handlings of material that does not have to go to the lye vats and necessitates a removable section of flooring over the storage pits. It is quite possible, however, that a saving of practically 20 ft. in crane length and in the width of the shop may offset this increase in cost.

Location and Arrangement of Machine Tools.

In the heavy machine bay the tools are all individual motor driven, both direct current and variable speed motors and induction constant speed motors being used, depending upon the tool that is to be driven, the latter being employed when the tool contains within itself a sufficient speed variation and the former where it is necessary to have speed changes on the motor in order to obtain the required range on the tool. In the light machine bay all of the smaller tools are grouped, these in most cases being arranged for group driving from an overhead shaft,



Cross Section through Bay No. 17.

SECTION OF NEW MACHINE AND ERECTING SHOP.

Reference to the three photographs showing the interior of the three bays clearly indicate that the value of generous natural lighting area has been fully appreciated by the designers. In the outside wall of the erecting shop above the crane runway it will be seen that practically the whole area is given up to glass. Below this the windows occupy over 75 per cent. of the whole area. On the opposite side of the erecting shop the extension of this section above the roof of the next bay is practically all of lighting area. In addition there is a skylight 31 ft. in width continuing the full length of the shop in the center. Altogether this makes this one of the best lighted erecting shops in the country. In the heavy machine bay the lighting is all from the vertical section of the saw-tooth roof, the windows being 13 ft. 3½ in. in height, and continuous for the full length of the shop. In the light tool bay the side windows are duplicates of those below the crane runway in the erecting shop and in addition a saw-tooth roof arrangement gives an excellent skylight near the center.

In the erecting shop, pits are provided on all three tracks, differing in this respect from most other longitudinal shops. They are 570 ft. long, located at 30 ft. 6 in. centers, the side pits being 14 ft. 6 in. from the wall. This gives an unusually large space between pits, allowing the storage of material taken from stripped locomotives which does not need repairs and still at the same time leaving ample clearance for workmen. The subject of the proper place for storing material of this nature is one on which there seems to be but little uniform opinion. It is, of course, preferable to store piping, lagging, steam chest covers, and other parts, which are to be again applied without repairs, in the immediate vicinity of the locomotive and in a place that will require the least number of handlings. With a longitudinal shop this, of course, can be done perfectly by leaving enough space between pits, but, on the other hand, space between pits means increased length of cranes and increased complication of roof trusses and other expenses, which mount up very rapidly and make it necessary to arrive at a compromise. Thirty feet and six inches, as is found in this shop, is the widest space of which we have any record and probably with proper care in the

although there are some individual driven tools in this section. There is no overhead traveling crane in the light machine bay and jib cranes, etc., will be installed for the handling of the work.

Referring to the illustration showing the arrangement of the tools, and beginning at the right end of the shop, it will be seen that a space of about 72 ft. along one side of the heavy machine bay is occupied by the lye vat and cleaning platforms. In addition to the service of the traveling crane there are two 20 ft. jib cranes arranged to handle material in and out of the vat. At this point there are two transverse tracks running between the outside pit in the erecting shop and the track that exends the full length along the center of the heavy machine bay. This permits the bringing of the material to the vat on push cars and transferring them out on the line of travel along the center track while they are getting unloaded. The other half of the heavy machine bay opposite the lye vat, as well as the next 80 ft. extending up to the transverse track that passes entirely across the shop and to the outside, is taken up by tools and space for the driving wheel work. The tracks for storing the wheels will be noted and the various lathes, presses and boring mills are indicated on the drawing. Of course in this shop a number of the tools have been transferred from the present shop. The new tools for wheel work include a 96 in. boring mill, a 100 in. quartering machine and a 42 in. car wheel lathe. In this section the only induction motors are on the quartering machine, the 600 ton hydraulic press and the 200 ton wheel press, in addition to the small grinder.

In the light machine tool bay, just back of the wheel section, are grouped a general collection of tools for miscellaneous work. These are all belted to a line shafting driven by a 20 h.p. induction motor forming group No. 6. Driving box and shoe and wedge work is taken care of by the tools occupying the next 112 ft. of the heavy machine bay. It will be noticed that there is a cylinder boring machine also located in this section, as well as a 96 in. and a 54 in. boring mill, which will be used for tire turning. In the light machine bay, just back of this section, is a tin and pipe department, with tools, benches, forges, etc.

The next group of tools is for rods, cross heads and piston

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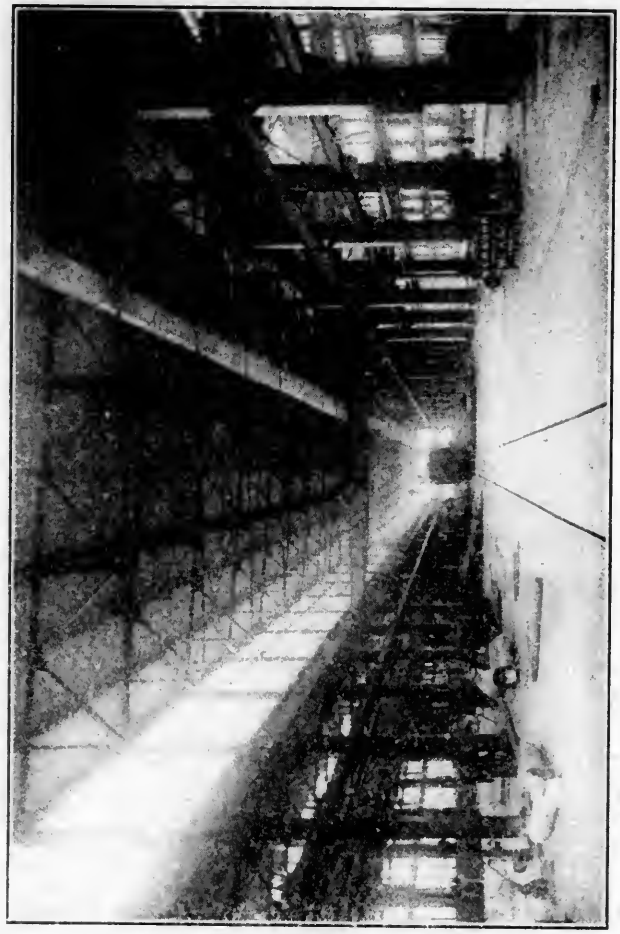

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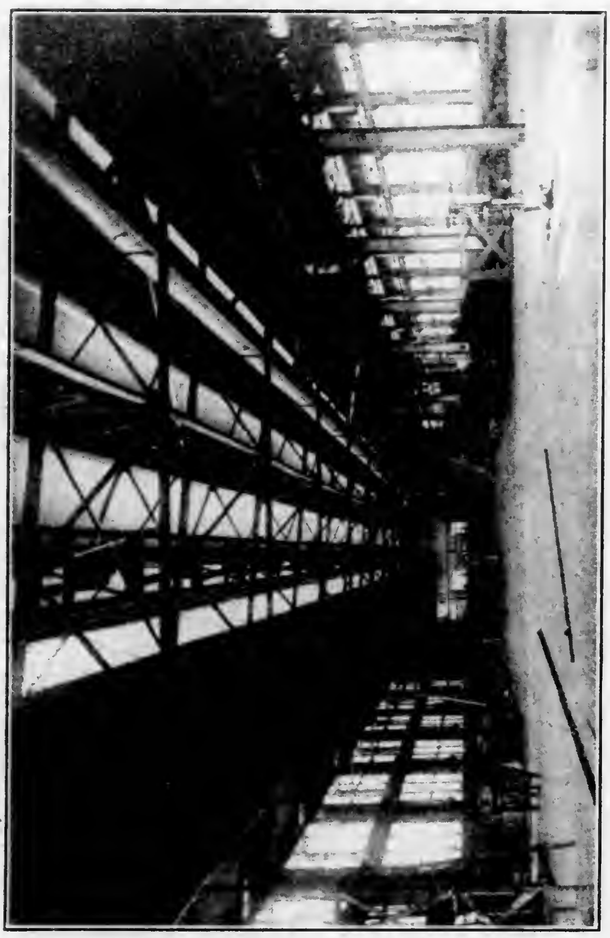

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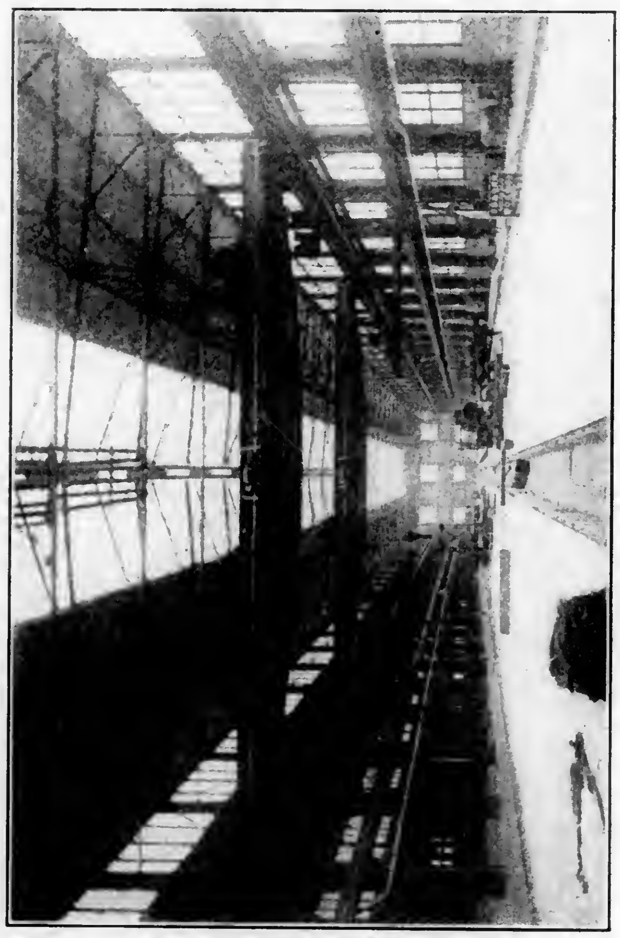

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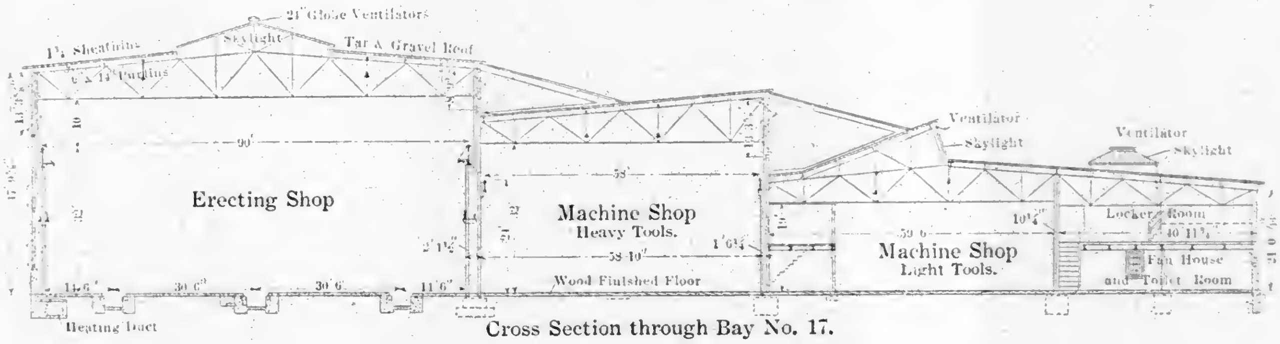

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SECTION OF NEW MACHINE AND ERECTING SHOP.

Reference to the three photographs showing the interior of the three bays clearly indicate that the value of generous natural lighting area has been fully appreciated by the designers. In the outside wall of the erecting shop above the crane runway it will be seen that practically the whole area is given up to glass. Below this the windows occupy over 75 per cent. of the whole area. On the opposite side of the erecting shop the extension of this section above the roof of the next bay is practically all of lighting area. In addition there is a skylight 31 ft. in width continuing the full length of the shop in the center. Altogether this makes this one of the best lighted erecting shops in the country. In the heavy machine bay the lighting is all from the vertical section of the saw-tooth roof, the windows being 13 ft. 3½ in. in height, and continuous for the full length of the shop. In the light tool bay the side windows are duplicates of those below the crane runway in the erecting shop and in addition a saw-tooth roof arrangement gives an excellent skylight near the center.

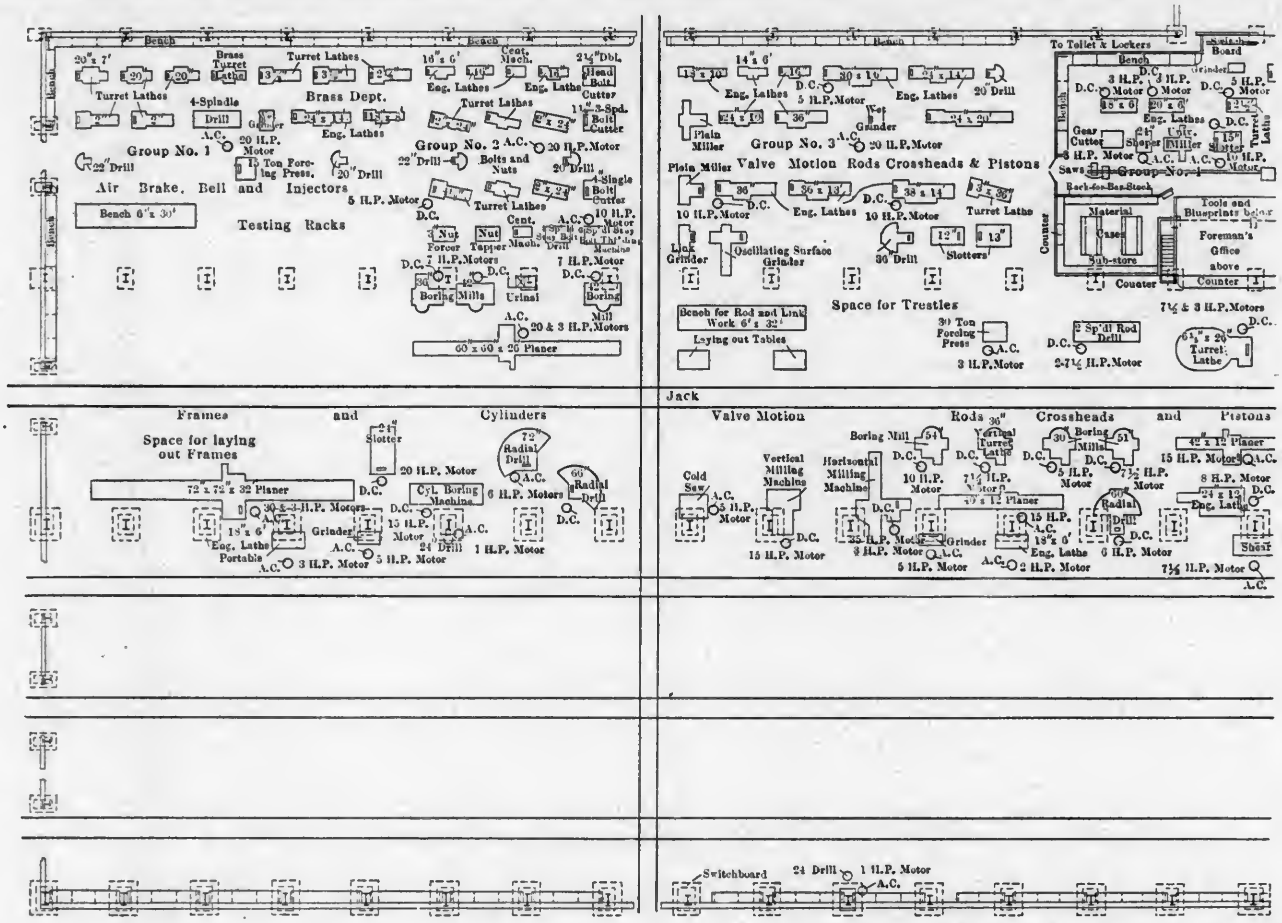
In the erecting shop, pits are provided on all three tracks, differing in this respect from most other longitudinal shops. They are 570 ft. long, located at 30 ft. 6 in. centers, the side pits being 14 ft. 6 in. from the wall. This gives an unusually large space between pits, allowing the storage of material taken from stripped locomotives which does not need repairs and still at the same time leaving ample clearance for workmen. The subject of the proper place for storing material of this nature is one on which there seems to be but little uniform opinion. It is, of course, preferable to store piping, lagging, steam chest covers, and other parts, which are to be again applied without repairs, in the immediate vicinity of the locomotive and in a place that will require the least number of handlings. With a longitudinal shop this, of course, can be done perfectly by leaving enough space between pits, but, on the other hand, space between pits means increased length of cranes and increased complication of roof trusses and other expenses, which mount up very rapidly and make it necessary to arrive at a compromise. Thirty feet and six inches, as is found in this shop, is the widest space of which we have any record and probably with proper care in the

although there are some individual driven tools in this section. There is no overhead traveling crane in the light machine bay and jib cranes, etc., will be installed for the handling of the work.

Referring to the illustration showing the arrangement of the tools, and beginning at the right end of the shop, it will be seen that a space of about 72 ft. along one side of the heavy machine bay is occupied by the lye vat and cleaning platforms. In addition to the service of the traveling crane there are two 20 ft. jib cranes arranged to handle material in and out of the vat. At this point there are two transverse tracks running between the outside pit in the erecting shop and the track that exends the full length along the center of the heavy machine bay. This permits the bringing of the material to the vat on push cars and transferring them out on the line of travel along the center track while they are getting unloaded. The other half of the heavy machine bay opposite the lye vat, as well as the next 80 ft. extending up to the transverse track that passes entirely across the shop and to the outside, is taken up by tools and space for the driving wheel work. The tracks for storing the wheels will be noted and the various lathes, presses and boring mills are indicated on the drawing. Of course in this shop a number of the tools have been transferred from the present shop. The new tools for wheel work include a 96 in. boring mill, a 100 in. quartering machine and a 42 in. car wheel lathe. In this section the only induction motors are on the quartering machine, the 600 ton hydraulic press and the 200 ton wheel press, in addition to the small grinder.

In the light machine tool bay, just back of the wheel section, are grouped a general collection of tools for miscellaneous work. These are all belted to a line shafting driven by a 20 h.p. induction motor forming group No. 6. Driving box and shoe and wedge work is taken care of by the tools occupying the next 112 ft. of the heavy machine bay. It will be noticed that there is a cylinder boring machine also located in this section, as well as a 96 in. and a 54 in. boring mill, which will be used for tire turning. In the light machine bay, just back of this section, is a tin and pipe department, with tools, benches, forges, etc.

The next group of tools is for rods, cross heads and piston



ARRANGEMENT OF TOOLS AND TRACKS IN NEW

work, taking up about 135 ft. in the heavy machine tool bay. Just beyond these are the tools for valve motion work, a liberal open space and large benches being provided in this neighborhood for fitting. In the light tool bay, back of these groups, is a tool room, which is liberal in size and very well arranged, there being a number of direct driven tools, as well as two groups, Nos. 4 and 5, located in the space next to the outside wall. Group No. 3 in the light machine tool bay includes the tools for valve motion, rods, cross head and piston work of a light character. This group is driven by a 20 h.p. alternating current motor. At this point there is another transverse track extending through the shop. The remaining 150 ft. of the shop is given up to large tools in the heavy bay for frames and cylinders, sufficient open floor space being provided for laying out and handling. Bolt and nut, air brake, etc., work is performed on the tools in groups Nos. 1 and 2 in the light machine tool bay in this end of the building.

It will also be noted that along the outer wall of the erecting shop there are two 24 in. drills driven by constant speed motors, on which emergency work can be performed by the erecting shop men. A number of small lathes, punch and shear, saw, grinders, etc., are placed inside of the columns on the other side of the erecting shop for small emergency work. There are also several portable lathes.

A study of this tool arrangement indicates the care that has been taken to reduce the transportation of material to a minimum. In each section there will be found tools suited for doing all parts of the work on any part of a locomotive, the lighter sections being machined on the small tools in the outside bay and the heavier work on the heavy tools under the crane and a space provided at each point for the assembling. For instance, all motion work is collected at the center of the shop; the driving box, shoe and wedge work is immediately adjacent to the driving wheel work, as it should be, and also near the cleaning vat, and so it goes throughout the shop.

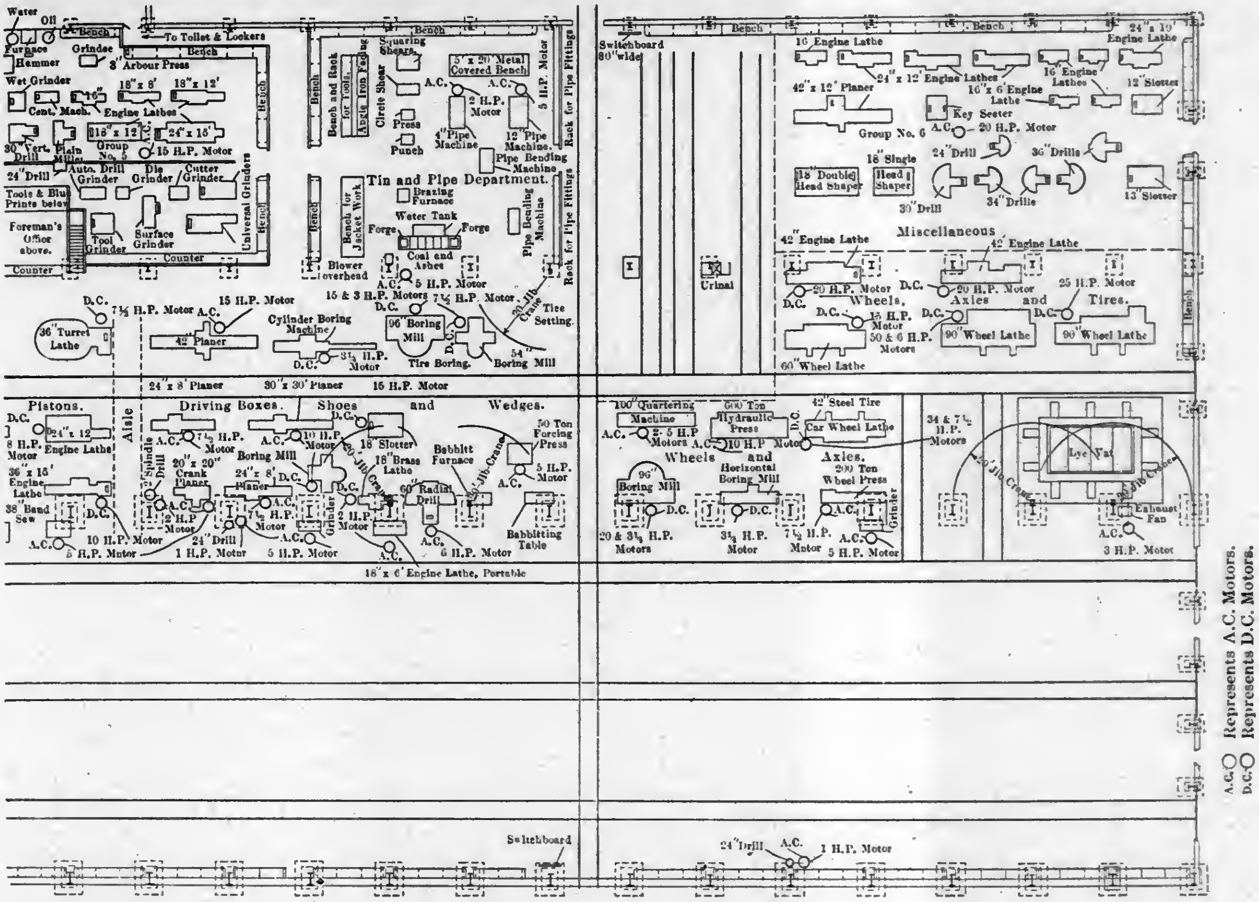
In a later issue, after the shop has been in operation for some time, we hope to be able to discuss this feature in view of the actual work being performed.

Extending out from the light machine tool bay in the center of the shop is a building about 41 x 61 ft., arranged in two floors, in which is located the fans, their coils and air intakes, and also a laboratory and a large locker room. The air from the fans is discharged through an underground conduit along one side of the erecting shop with exits close to the posts and just inside of the wall. For the other bays of the shop the hot air is conveyed through overhead galvanized iron piping with discharges at every alternate posts in all bays.

STOREHOUSE.

One of the largest railroad storehouses in the country forms part of this plant. It is a building 80 ft. in width, 500 ft. long, and three stories high, parallel to and 150 ft. away from the erecting shop. The building is of slow burning mill construction with brick walls and is surrounded on three sides by a platform 16 ft. in width. 100 ft. of the first and second floors at the west end of the building is reserved for office use. On the first floor are situated the quarters of the superintendent of shop and the storekeeper, while on the scond floor are located the stationer, doctor, who is provided with an emergency hospital fully equipped, telephone exchange, quarters for the apprentice school, and a meeting room.

This storehouse is intended to be the main distributing center for all material used on the Western Grand Division of the railroad. On the first floor are located cases for holding the material handled in the largest quanties, as well as the receiving and shipping rooms. On the second floor is the stock of stationery and material cases for handling the small stock. The third floor is given up to the storage of material in original packages, which is not worked over in the storehouse, or is of a bulky nature. Two motor driven elevators are provided, serv-



MACHINE AND ERECTING SHOP AT HAVELOCK.

ing all three floors, one being located in the receiving room on the first floor and the other in the shipping room.

An interesting feature of the design of this building is that the form of material case to be used was first adopted and then the windows and framing were designed to suit the cases. These cases are 5 ft. in width at the bottom and are separatel by a space of the same width, making the spacing of windows at 10 ft. centers. The windows themselves are 7 ft. in width and located directly opposite the aisle between the cases.

The heating of this building is by direct radiation in the office section and by indirect system, having duplicate fans, in the storeroom section. It is lighted throughout by incandescent lamps.

Just to the north of the storehouse, and separated from the platform on that side by the clearance of one track, is a large casting platform 60 ft. in width and 518 ft. long, built at car floor level. This, and the track serving it to the north, are covered by a 10 ton, 59 ft. girder crane, the runway of which extends far enough under the yard crane to permit the transfer of material between the two without rehandling. Between this platform and the erecting shop there is a space of 62 ft. in which there are two tracks, the remainder of the space next to the erecting shop itself being clear and to be used for the storage of little used material or parts.

OIL HOUSE.

Situated west of the erecting shop and storehouse at a distance of 220 ft. is the oil house. This structure, which is built entirely of concrete below the platform line, has side walls of brick and roof of concrete, water proofed with a five ply pitch felt and gravel covering. Special attention has been given to making the building entirely fireproof and no combustible material has been used anywhere in its construction. Tanks for storage of the various oils with the exception of kerosene and gasolene are located in the basement of the building and under the platform. Kerosene and gasolene are stored outside in two elevated tanks, each having a capacity of 20,000 gallons. These oils are handled to the storage tanks from cars by motor driven power pumps located in a separate compartment on the west side of the building. From the tanks kerosene and gasolene is distributed and barrels filled by gravity. For handling oils stored in the tanks located in the basement and used in considerable quantities, five Gilbert and Barker power pumps, each having a capacity of 40 gallons per minute, are provided. Ten Bowser self-measuring pumps are also located in the pump room for handling as many different kinds of oils in small quantities. The power pumps are driven from line shafting run by a 3 horsepower 440 volt Westinghouse A. C. motor.

The tank capacities and the list of oils to be handled is as follows:

Kerosene	20,000	gallons
Gasoline	20,000	"
Fuel	24,000	"
Car	24,000	"
Valve	12,000	"
Mineral Seal	8,000	"
Black	500	"
Gas Engine	500	"
Renown Engine	500	"
Franklin Engine	500	"
Linseed	500	"

A compartment 20 x 36 ft. is provided in the building for the storage of baled waste. For the easy handling of this material an overhead trolley arrangement has been installed.

POWER HOUSE.

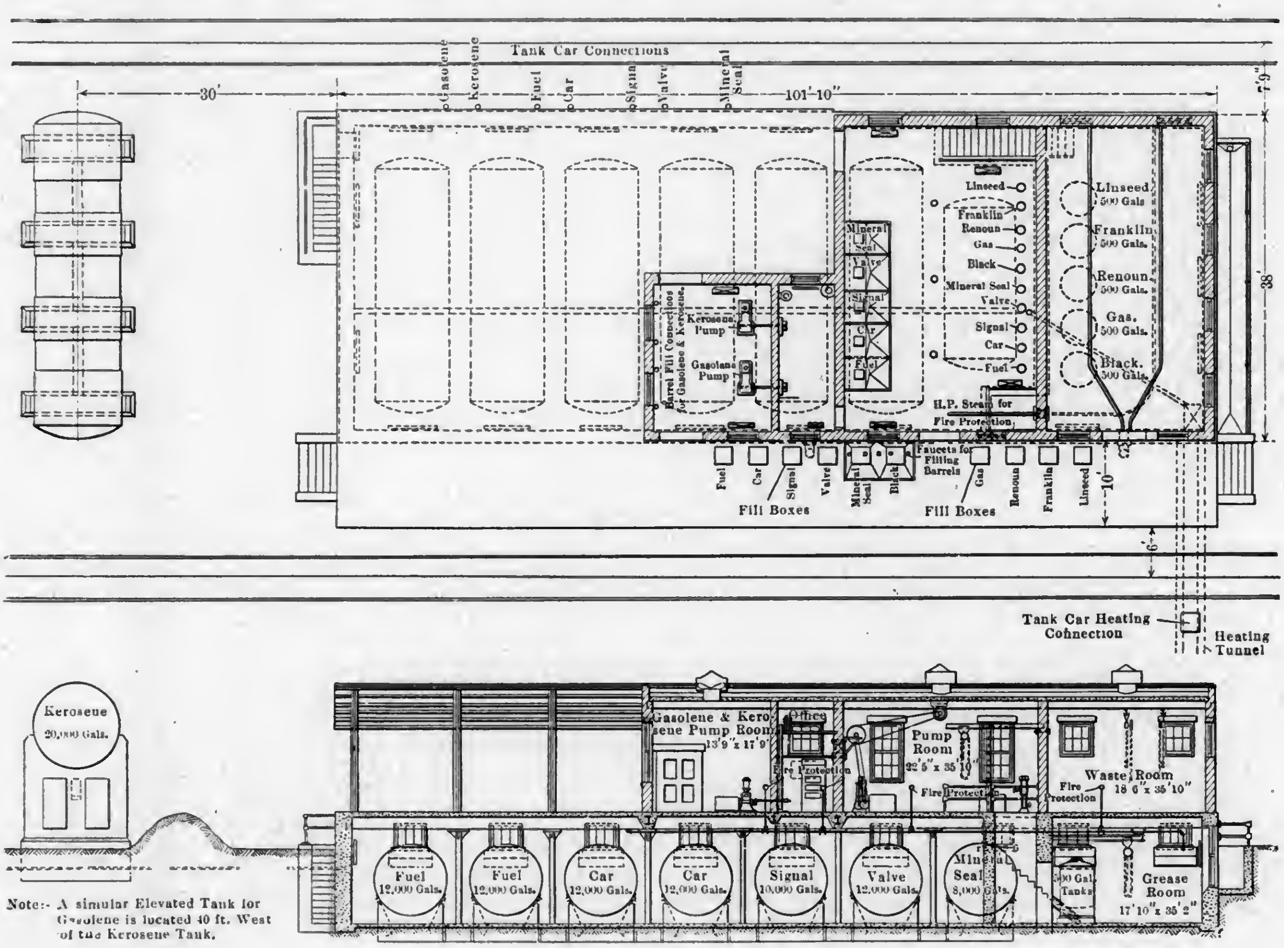
A power house, thoroughly modern in every respect, forms not the least important part of this shop plant. Its location can be seen by reference to the general view. It is a brick structure, with a concrete roof covered with five-ply felt pitch and gravel

covering. It measures 87 ft. 7 in. x 120 ft. outside dimensions, and is divided into practically two equal longitudinal sections, the one to the north being the boiler room and the other the engine room. In the former are at present provided four 400 h.p. Sterling boilers, arranged in two batteries; space is also provided for the installation of two additional units of the same size. The boilers are equipped with Green chain grate stokers and furnish saturated steam at 150 lbs. pressure. Special attention has been given to the mchanical handling of coal and ashes. The coal is discharged into a track hopper just outside the power house, and conveyed to the concrete bunkers over the boilers by an inclined belt conveyor. From these hoppers it is fed directly to the chain grates by gravity. The ashes discharge into small ash cars located in a tunnel beneath the boilers, which are hoisted to an overhead hopper, into which they are automatically dumped. From this hopper they are discharged into the ash cars outside of the building without further handling.

The other boiler room equipment consists of two Blake 14 x 8 x 12 in. plunger type duplex boiler feed pumps and a 3,000 h.p. Stillwell feed water heater, the latter being located on a platform over the feed pumps. The stack is 200 ft. in height, built of reinforced concrete, the construction work being by the General Concrete Construction Co. A Locke damper regulator has also been installed.

In the engine room there is one 750 k. v. a. Westinghouse generator driven by a Parsons turbine. Foundations and space are also provided for two additional turbines of the same size, to serve future requirements. A 200 kw. Westinghouse generator direct connected to a 300 h.p. Erie Ball cross compound engine has been transferred from the old power house. There is also one 100 kw. and one 200 kw. Westinghouse induction motor generator set, which furnish direct current at 220 volts for the operation of the motors of this type on some of the machine tools, as well as all crane motors. The current from the alternators is 3-phase, 60 cycle, at 440 volts, is used for general lighting and for all constant speed motors throughout the plant. In addition a 25 kw., 125 volt Curtis turbo generator and a 25 kw., 125 volt Westinghouse motor generator set, are provided for exciting and auxiliary lighting purposes. In the engine room are also found an Ingersoll-Sargent cross compound two stage class G air compressor having a capacity of 2,100 cu. ft. of free air per minute, as well as a Franklin duplex two-stage compressor of 2,000 cu. ft. capacity.

In the basement of the engine room are the pumps for water and fire service, as well as a Westinghouse LeBlanc motor driven condenser for handling the steam from the turbine.



PLAN AND ELEVATION OF OIL HOUSE AT HAVELOCK.

Adjacent to the power house is a large concrete reservoir of 1,000,000 gallons capacity, which in addition to the water supply is also used for cooling purposes, the discharge from the turbine condensor being sprayed through Koerting nozzles.

All piping between the power house and various buildings is carried in a concrete tunnel or in conduits. The wiring is entirely overhead, being carried on steel towers and wooden poles.

Yard Crane.

The yard crane is of 40 tons capacity, the runways being 30 ft. in height and 80 ft. apart. It adjoins the machine and erecting, smith and car shops, and is but 40 ft. away from the end of the boiler shop, and also, as above mentioned, serves the end of the casting platform. Passing underneath it at right angles there are 11 tracks, of which two serve the casting platform, three enter the erecting shop, one passes through the heavy machine bay, one through the smith shop and two enter the boiler shop. This makes it possible to transfer any heavy material from a car on any track directly to the shop wherein it is to

be used. This and all other cranes in the plant were furnished by Niles-Bement-Pond Co.

BOILER AND SMITH SHOPS.

The old erecting shop and the old boiler shop are very well suited for their new uses. Both of them have overhead traveling cranes, the former being a 30-ton girder crane, 59 ft. in length, serving half the width of the shop. There are two of these cranes in this shop of the rope drive type, but it is planned to replace them with electric driven cranes on the same runway.

All engineering work of this plant, including the design and construction of the buildings, has been in charge of Westinghouse, Church, Kerr & Co., 10 Bridge St., New York. The work has been under the direct supervision of Mr. F. H. Clark, Gen. S. M. P., and Thomas Roope, S. M. P., of the lines east of the Missouri River, and Willard Doud, shop engineer of the Burlington Lines.

COMPARATIVE TEST OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE WITH SUPERHEATER

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

On page 467 of the December, 1909, issue of this journal appeared a very fully illustrated description of a 4-cylinder balanced simple locomotive of the Atlantic type, which was equipped with a Cole high degree superheater with side headers, of which two were built by the American Locomotive Company for the Chicago, Rock Island & Pacific Railway. These are the only examples of 4-cylinder simple locomotives with superheater that are in service in this country, although the same type has been in successful use abroad for a number of years.

Upon delivery, these two engines were put into service on the Illinois Division, between Chicago and Rock Island, a distance of 181.1 miles, and were used for hauling the fastest and most important passenger trains on that division. Other power also in use on the same division includes 4-cylinder balanced compound non-superheater Atlantic type engines built by the Baldwin Locomotive Works in 1905* and 2-cylinder single expansion locomotives of the same type, some of which have superheaters and others are non-superheater.† These locomotives were built by the American Locomotive Company.

Full advantage has been taken by the motive power department of that road to avail itself of the excellent opportunity of determining the relative value of the various designs of the same type of locomotive in the same service and during two weeks early in 1910 a series of comparative tests were made to determine the relative coal consumption and other factors of the different locomotives. The ones chosen for test were No. 1016, a 2-cylinder, single expansion, non-superheater engine; No. 1045, a 4-cylinder, Baldwin balanced compound, and No. 1041, a 4-cylinder balanced simple with superheater. These tests were made with regular trains, Nos. 7 and 8, between Chicago and Rock Island, and in the table below are shown the average result of six trips with each locomotive, three in either direction. The trains on every trip, with one exception, consisted of seven cars and the tonnage hauled was approximately the same in all the trials.

Inasmuch as the tests were conducted in very severe winter weather, the results obtained represented the performance of each locomotive under adverse conditions and therefore bring out more clearly the relative efficiency of the three classes as concerns fuel consumption.

The line from Chicago to Rock Island is practically level, all grades are short, the maximum grade being but 40 ft. to the mile. None of the curves are sharp, the worst one being 4 degs. 30 min.

A study of the results in the table will show that the balanced simple was decidedly more economical on both coal and water, and also that the balanced compound was more economical than the simple in coal and about the same on water consumption.

Of course, while coal and water economy are of great importance, the total efficiency of a locomotive must also include its cost of maintenance, and on this feature Bulletin No. 1007, issued by the American Locomotive Company, to whom we are indebted for this data, states that all three of these locomotives required almost exactly the same expense per engine mile for running repairs and that the saving of a balanced simple on coal and water is a net saving which is not offset by a greater expense of up-keep.

Locomotive No.	1016	1045	1041
Type	4-4-2 Simple	4-4-2 Bal. Comp.	4-4-2 Bal. Simple
Total weight, lbs.	180,000	199,400	202,000
Weight on drivers, lbs.	102,000	105,540	116,000
Cylinders, diam. and stroke	21 x 26	15 & 25 x 26	17½ & 17½ x 26
Diameter drivers, in.	73	73	73
Steam pressure, lbs.	185	210	170
Tractive effort, lbs.	24,700	22,500	29,600
Total heating surface, sq. ft.	2,825.5	3,209	2,715
Number and size of flues	320—2	273—2¼	206—2 24—5¼
Length of flues, ft. and in.	16-0	18-10	18-0
Flue heating surface, sq. ft.	2,667	3,015	2,551
Grate area, sq. ft.	44.86	50.4	42.8
Mileage since No. 1 or 2 repairs	24,623	34,324	12,680
TIME AND TONNAGE.			
Distance between terminals, miles	181.1	181.1	181.1
Average total time, hrs. and min.	5-6	5-7	5-58¾
Avg, running time, hrs., min. and sec.	4-32-26	4-46-36	4-34-13
Number of stops, average	6.33	7.15	14.6
Miles per hr (based on running time)	39.96	37.98	39.63
Number of cars	7	7.165	7
Weight behind drawbar, tons	401.24	406.47	404.05
WATER CONSUMPTION.			
Avg. temperature of feed water, degs. F.	42.3	42.18	42.16
Average steam pressure, lbs.	177.3	195.4	170.5
Weight water fed to boiler (lbs. per hr.)	22,120	22,324	16,650
Equivalent evaporation per hr., lbs.	27,100	27,350	20,400
Equiv. evap. per sq. ft. H. S. per hr., lbs.	9.6	8.53	7.42
Equivalent evaporation per ton mile, lbs.	1.907	1.911	1.67
Equivalent evaporation per lb. coal, lbs.	6.65	7.47	7.00
Equiv. evaporation per lb. dry coal, lbs.	7.07	7.77	7.47
COAL CONSUMPTION.			
Total weight of coal used, lbs.	20,852	18,832	17,466
Per cent. moisture in coal	5.95	3.91	6.28
Per cent. combustible in coal	84.47	84.36	83.81
Average coal per ton mile, lbs.	.2868	.2557	.2385
Average dry coal per ton mile	.2696	.2456	.2236
Average combustible per ton mile	.2422	.2157	.1999

NOTE.—Tests made during severe weather with range of temperature from 2.5 to 36.5 degrees.

SUCCESSFUL SALESMANSHIP means correct theory put into successful practice. It means the welding of self-reliance to up-to-date co-operative methods; it means the conversion of capacity into ability; it means facing with courage life's conditions as they are, and adapting one's self advantageously to such conditions. It means the proper adjustment of self into the machinery of commerce and human affairs. It means adaptability, resourcefulness, courage, patience, fortitude, quick perception, optimism and enthusiasm. It means, in its higher sense, skillful and harmonious execution upon the keyboard of human nature. The profession is dignified enough and its highest exactions are universal enough to challenge the admiration, interest and genius of the greatest intellects.—*T. H. Bailey Whipple in the Electric Journal.*

TELEPHONE DISPATCHING ON THE LOUISVILLE & NASHVILLE RY.—The Louisville & Nashville has ordered a complete equipment of Western Electric selectors and telephones for train dispatching on the Cumberland Valley and Kentucky divisions, from Cincinnati to Norton, 304 miles. There will be six circuits, four train wires and two message circuits, with a total of 162 stations. The message wire circuits to be used for general railway business extend from Paris to Cincinnati, from Cincinnati to Corbin, and from Corbin to Norton. The Louisville & Nashville already has Western Electric train dispatching equipment between New Orleans and Mobile, 140 miles.

DEPARTMENT OF AGRICULTURE reports imply that last summer's forest fires either burned or killed between one and two per cent. of the total stand of national forest timber. The total amount of timber killed or destroyed in Montana and Northern Idaho was over six billion board feet, and the area burned over is put at over one and one-quarter million acres.

* For full dimensions and general description, see AMERICAN ENGINEER, November, 1905, p. 416.
† For full dimensions and general description, see AMERICAN ENGINEER, Sept., 1905, p. 329.

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ADVERTISEMENTS—Nothing will be inserted in this journal for pay, **except in the advertising pages.** The reading pages will contain only such matter as we consider of interest to our readers.

CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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THE RAILROAD CLUBS

Surprise has many times been expressed that more real benefit to the railroads of this country has not been obtained through the organized railroad clubs located in the principal railroad centers throughout America. While, of course, all of these clubs are of more or less value to their members, this becomes insignificant when it is considered what they might be, not only to their own members, but also to the members of all other clubs. Here is really a clearing house for the observations and experiences of the best men in the country, already organized, from which not one-tenth part of their value is available for general use.

C. E. Turner several years ago suggested in these columns that all of the clubs throughout the country discuss the same subject at corresponding meetings. Mr. Vaughan in his presidential address before the Master Mechanics' Association in 1909 suggested that the railroad clubs should be depended upon to thoroughly thresh out the subjects which were to come before the Association, so that decisive and positive conclusions could be reached on the various important subjects that were brought up.

Both of these suggestions are excellent, and it is now further suggested that all of the clubs affiliate into one organization, and that a permanent secretary, provided with suitable office force and properly recompensed, be employed. Further, that the American Railway Association be requested to name a consulting board who should decide what subjects are most worthy of discussion, and that the permanent secretary through the medium of the local secretaries obtain papers to be presented by each of the various clubs on this subject, where it could be thoroughly and completely discussed. The papers, with the discussion, should be returned to the permanent secretary, who would condense them and put the whole matter into suitable shape for publication and for the use of the committee who might be preparing a report on the same subject for one of the National Associations.

This suggestion, while capable of criticism on a number of points, and possibly not suitable for adoption in its entirety, still has many points of practicability, and if somethinqg of this kind could be brought about the proceedings of the Associated Railroad Clubs of America would be the most valuable source of information on railroad topics that could possibly be compiled, and with the certainty assured of results which in prospect are now largely speculative.

AN UNDERLYING FACTOR IN LOCOMOTIVE HIGH SPEED DEVELOPMENT

It is not a matter of very great difficulty to trace why the railroads of other countries have further progressed in making minutes equal miles than what has been accomplished here. The development which the high speed locomotive has attained abroad, and particularly in England and France, is largely due to the high plane ocupied by the motive power department in the scheme of organization which prevails in those countries. The able men who are at the head of this particular branch of the service are free to work out their ideas in practical form, and to remain untrammelled by the interference which too often here renders the mechanical department subordinate to a degree far out of keeping with its real importance.

The foreign motive power chief is supreme in his capacity. He reports only to the board of directors, and he has large funds appropriated annually for the sole conduct of experimental work along the lines which might accrue to the benefit of the service. Consequently a thing which is known to be good does not have to be abandoned merely on account of some incipient failure in minor details, or when the costs commence to run up without definite return. On the contrary, the advantageous arrangement prevailing is such that errors can be corrected and

the entire scheme slowly perfected until it is capable of doing better work than the existing appliances.

The mechanical department thus endowed with positive authority can afford to spend the money in the necessary education of the men who will handle any new type of power which it may have evolved. In France, through an admirable system of premiums, it rewards the engineers and firemen for good work, as it just as effectively, through a system of fines, punishes them for any dereliction of duty. The principal effort, however, is to imbue these men with the spirit of hearty cooperation, and the success of this laudable endeavor does not fall far short in constituting the real reason why the United States has been outstripped in the speed question at least.

They have nothing to learn from us, but we have much to learn from them in the conduct of this particular feature, and until the position as head of the motive power department is endowed with the dignity and given the latitude in the way of expenditure which should properly be associated with it, not to mention freedom from interference, that department cannot assume the lead in working out these world problems, which in all other respects it is eminently qualified to do.

GASTON DU BOUSOUET

Locomotive development in France, if not throughout continental Europe, may suffer retardation through the recent death of M. du Bousquet, chief mechanical engineer of the *Chemin de fer du Nord,* as it is doubtful whether another motive power chief can be found with sufficient courage to undertake the bold experimental work which had become so thoroughly identified with this eminent executive, and from which the railroad world at large has profited. It is needless to recount the many useful things which M. du Bousquet has done, but it will be remembered that he was the first to apply the 4-cylinder compound principle of De Glehn on the French Northern Railroad, and that through his untiring efforts it became the recognized type for high speed work abroad.

This truly efficient machine will remain as his greatest monument, but in many other details his memory will be perpetuated in foreign railroad service. He designed the powerful suburban tank locomotive, which so simplified the great problem in connection with the Paris morning and evening travel, and he courageously introduced into the practice of his road the 4-wheel pivoted truck for passenger cars in defiance of the time-honored rigid pedestal arrangement. The last, however, and probably what will prove the greatest effort in a useful lifetime, was in the perfection of a water tube fire box for locomotives, on which he worked with jealous care, but was denied the reward of observing in practical operation.

M. du Bousquet occupied an enviable position as an organizer without a peer. A no mean factor in the success of the necessarily complicated De Glehn locomotive was the careful and patient training of the men who handled it. The running skill of his engineers, which cannot be surpassed, is a tribute to the thoroughness with which this training was accomplished. He believed in educating the men to a thorough appreciation of every new device as a preliminary to its appearance, and above all things he sought to place them in sympathetic accord with them.

For 48 years he had charge of motive power on the French Northern Railway and passed away with full recognition established of his genius and ability. For 14 years he had been a member of the Legion of Honor; he had been president of the important Society of Civil Engineers; was a member of the Council for the advance of the Central School, and held a large number of foreign decorations.

AN AWAKENING TO THE IMPORTANCE OF STANDARD REPAIR PRACTICES

To secure uniformity in the various repair and renewal operations, which are associated with locomotive maintenance, should properly be regarded as an essential feature on any railroad and particularly in instances where it is composed of a number of self-supporting divisions, those in possession of sufficient facilities to render it unnecessary for their engines to be sent to the system's general shop for overhauling. Under such conditions each division, isolated as it is under the direct supervision of its local mechanical management, becomes practically a complete railroad in itself and when the system of standardized shop practice, or practically maintenance practice, is lacking, it is quite likely to take the initiative in deciding points which are frequently arising in regard to repairs and renewals.

In consequence many railroads exhibit much diversity of opinion and practice within themselves. Work done at one shop may be at utter variance with that performed in another, so much so in fact as to be practically unrecognizable, and illustrations are numerous where parts are allowed to continue in service on one division although condemned when in far less serious condition elsewhere. This was a very prominent feature of railroading all over the country not more than 20 years ago, when what was going on in a shop 100 miles away from its nearest neighbor was a sealed book. The old school master mechanics exhibited much the feeling which is now so evident among English locomotive superintendents; when they had a good thing they wanted to reserve it for themselves, and even the heads of the motive power department were apparently not sufficiently progressive to encourage the interchange of ideas.

Standard repair practice is even to-day practically a new and undeveloped scheme. It has not progressed with the rapidity and certainty which has been so characteristic of the standardization of parts or of equipment, or even shop organization. Definite reasons cannot be assigned for their lack of interest in a subject so important, but a conjecture at least is that a great many superintendents of motive power do not believe in giving too detailed instructions to the shop as to how the work shall be carried out, because they opine that this practice is liable to produce automatic rather than active wide-awake foremen who feel their responsibility and the necessity of some initiative on their part.

Close familiarity, however, with the actual daily demand on a foreman's time will readily establish this view as fallacious. His work is not ordinarily to direct men in the performance of their duties, but to plan for rapid output and to stand ready at all times to cope promptly with the unexpected, which must necessarily arise no matter how perfect the system of organization may be. Thus it would appear that if the commoner operations of locomotive repairs were standardized the value of the foreman would be increased through more time being permitted him for the consideration of ends and means.

There is no point in favor of giving the subject more attention than it has received in the fact that it would establish the cost of repairs on a basis which would permit of better comparison between one shop and another. The majority of the railroads follow the plan of issuing statements showing the cost of various classified repairs at all shops on their line, and quite frequently these figures have a material bearing on the status of a master mechanic. This is a rather unjust procedure because through the lack of uniformity in practices followed it may cost considerably more to do the job at one point than at another. A partial standardization, at least, of such operation must certainly endow these reports with more value than they possess at present and the importance of this point will be generally recognized.

Reports from twenty roads, to whom this journal addressed a circular letter asking for information on their procedure in this direction, show that in but two instances there is anything like thorough standardization. On eight roads the matter is in strictly the formative stage, while ten replies indicate practically no repair standards, allowing the various shop heads to assume the initiative. The various wear limits allowed, which have been featured in the article on another page, are interesting as illustrative of the views entertained by the various motive power managements. The tone of their correspondence in general reflected that the entire matter is considered as a good and rapidly awakening proposition, and it is believed that much will be done to make it of more general scope within the near future.

WELDING MAIN RODS

The conversion of compound to simple engines, which has been a prominent feature in repair shop work on a number of roads during the past few years, draws attention again to the time-honored and still unsettled question as to whether main rods can be so satisfactorily welded as to be safely returned to service. Heretofore this practice has not been viewed with favor by the large majority of master mechanics, although practically universal in the instance of side rods, it being considered preferable to get out an entire new rod than to take what was regarded as a chance. Since the conversion of compounds, however, necessitates a radical change in the existing main rod, the renewal of this latter part on that occasion has resulted in the addition to the bill of a formidable item of expense, and various expedients are now being resorted to in order that the bulk of the rod can be saved by piecing it.

In the case of the original four-cylinder Vauclain compound, for instance, the front end of its main rod cannot be well adapted to the crosshead and guide arrangement necessitated by the simple cylinders, as its key slot is vertical, whereas the horizontal slot is generally preferred. If it is not desired to piece the rod this means throwing away the entire part, where, with about fourteen inches cut off and a new end added would save it. A new main rod, including forging, machining, etc., can be easily set down at one hundred dollars, thus increasing the high cost of conversion by two hundred dollars for each engine, less, of course, the scrap credit for the old parts.

While fully appreciating the necessity for maximum strength in so important a part, we do not share the general distrust associated with the thought of welding or piecing it when necessary. Realizing the importance, from an economical as well as a practical standpoint, of this subject, the forging operations in several prominent shops have been investigated, and from the data gathered the following composite practices have been evolved, and which are presented for the interest which they undoubtedly possess. Since a commoner weld has been wrongfully considered adequate for side rods we have included both side and main rods in the same operation in order that the very best work may be secured in connection with both important parts.

CHANNELED OR FLUTED MAIN AND SIDE RODS OF IRON.

Short heat to be taken six or seven inches from end and upset good. A slab should then be laid in channel on either side and common scrap weld effected.

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Broken ends well upset to give plenty of stock. A long scarf to be made and to the surface of the scarf a piece of iron ¾ in. thick, and as wide and long as the scarfed end of the rod should be welded. This provides an iron surface for the welding. After weld is made the rod to be drawn to correct length and straightened. All rods to be thoroughly annealed.

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Results have been observed where the above practices have been applied to rods which failed in service which were entirely satisfactory, and they are equally applicable to cases where rods must be pieced with a new end arising through change in the design. Rods should never be re-channeled in any case after the weld has been made.

The Pilliod Locomotive Valve Gear

INGENIOUS MECHANISM FOR IMPARTING VALVE MOTION THROUGH CROSSHEAD CONNECTION, WITHOUT THE EMPLOYMENT OF EITHER ECCENTRIC OR RETURN CRANK.

The rapid growth in popularity of the Walschaert valve gear since its introduction into American practice has not by any means exerted a deterrent effect on the efforts of many clever mechanics, who for varying periods have been endeavoring to perfect other and simpler arrangements for steam distribution. Their consideration of the subject has been largely based on the necessity for evolving some form of outside valve gear, which every new locomotive makes apparent through the continually decreasing space for motion work underneath the engine; and to present a gear, which in its omission of the fixed or shifting link, will eradicate the errors inseparable from that device in whatever form it may be employed.

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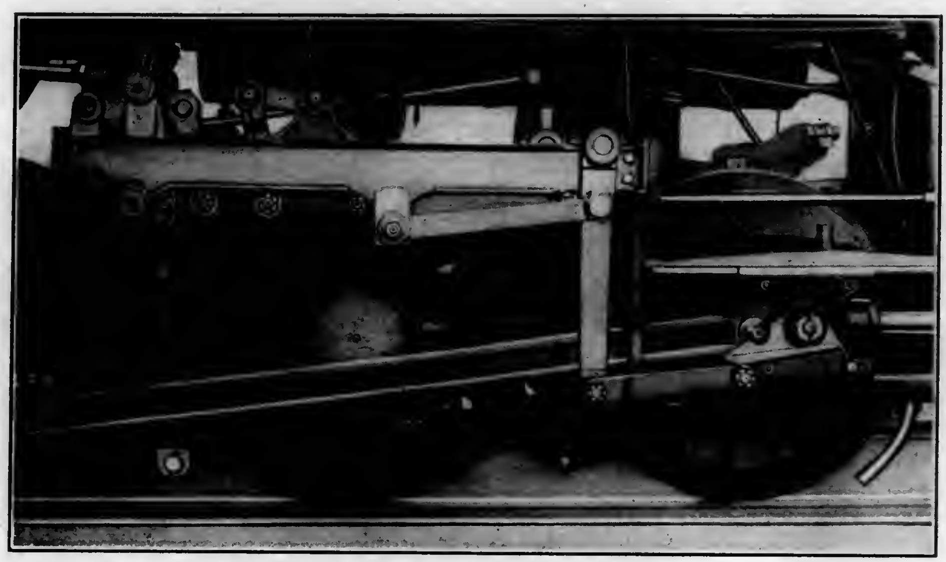
point (O). At an intermediate point the eccentric arm (M) is connected at (T) with the lever to the radius bar (G), by the pin (U).

As the crank (C) imparts a circular motion to the front end of the eccentric arm the lever connecting the eccentric arm and the radius bar permits the other end of the eccentric arm to travel in varied planes according to the positions of the cut-off, governed by the reverse yoke at the control of the engineer.



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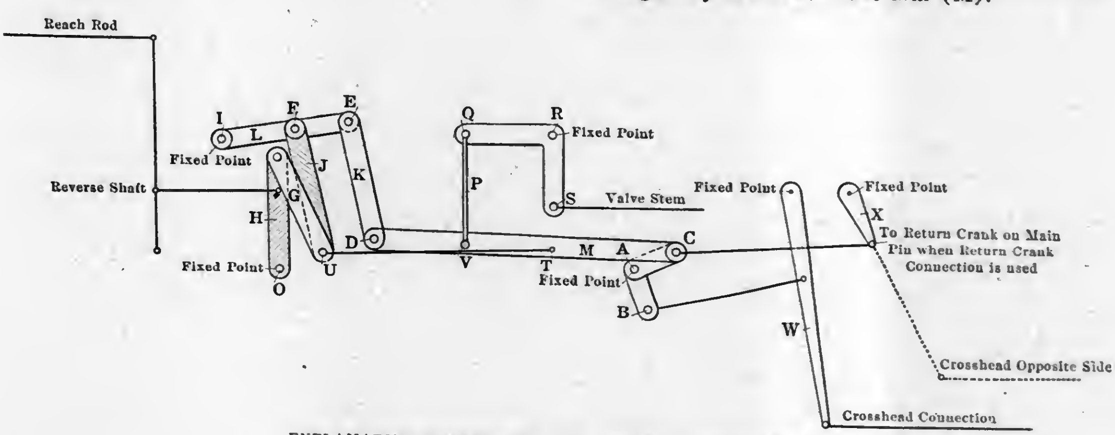
The oscillation of the radius yoke, through the radius link, raises and lowers the front rocker arm (L), and imparts vertical movement to the forward end of the eccentric arm (M), and the combined horizontal and vertical reciprocatory motions cause the intermediate pivot (V) and the end pivot (D) to travel in elliptical paths.

The intermediate pivot describes a perfect ellipse, that is, an ellipse where there is an equal amount of travel on each side of the center line of the motion, modified by the radius of the intermediate link (P); while the end pivot describes a very elongated ellipse, and compensates for and dissipates the effects of the angularity of the eccentric arm (M).



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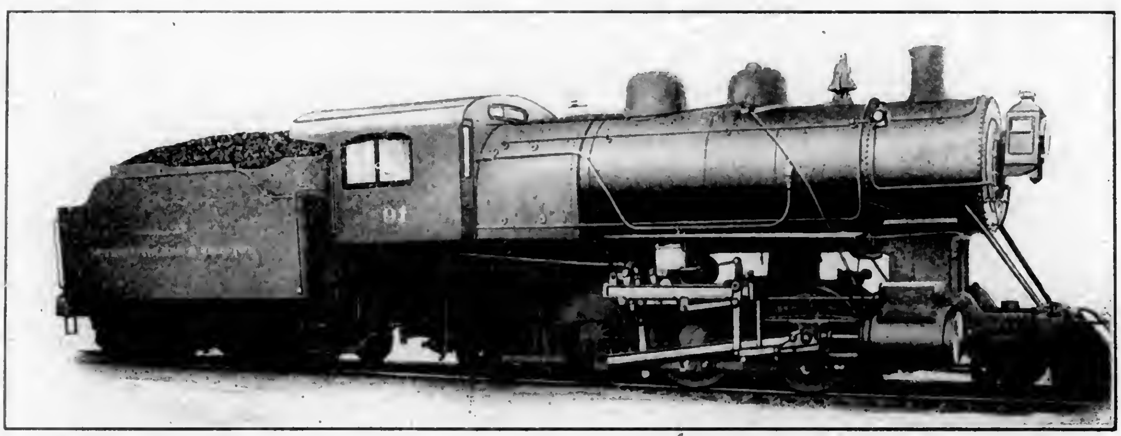

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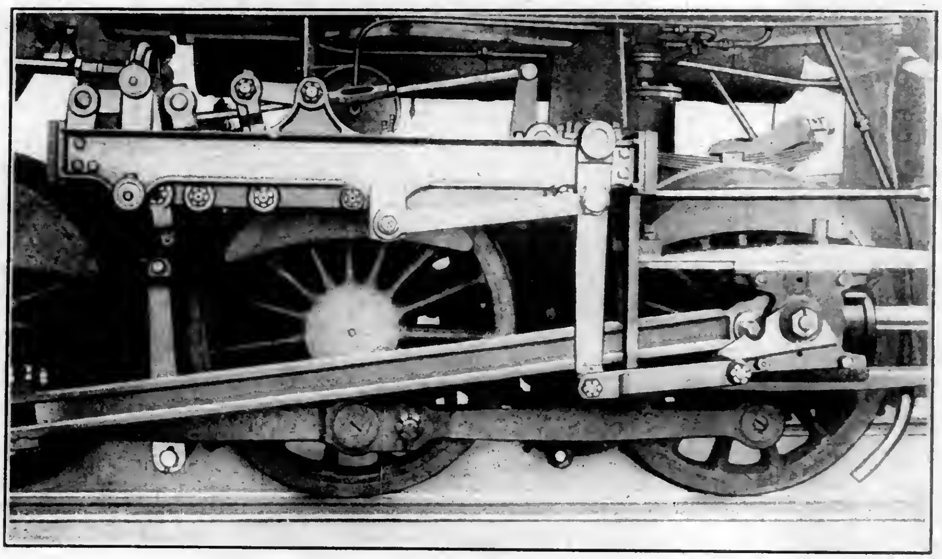

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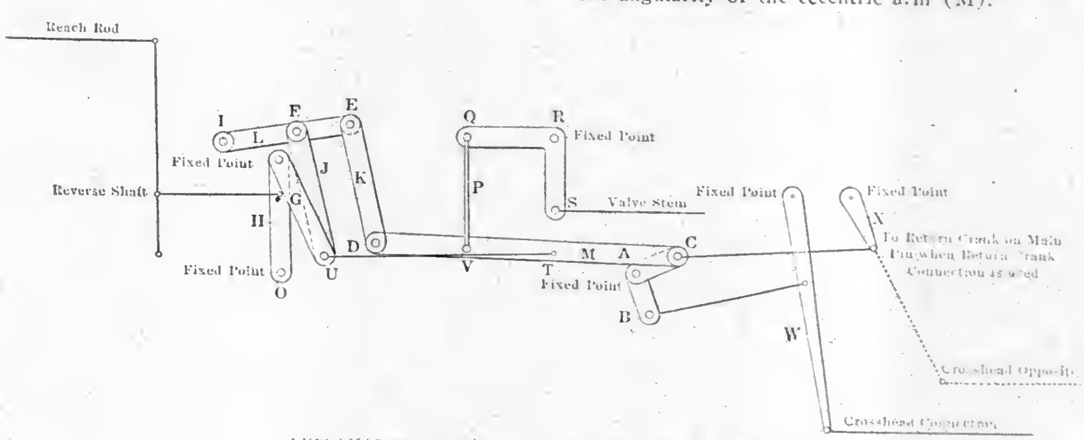

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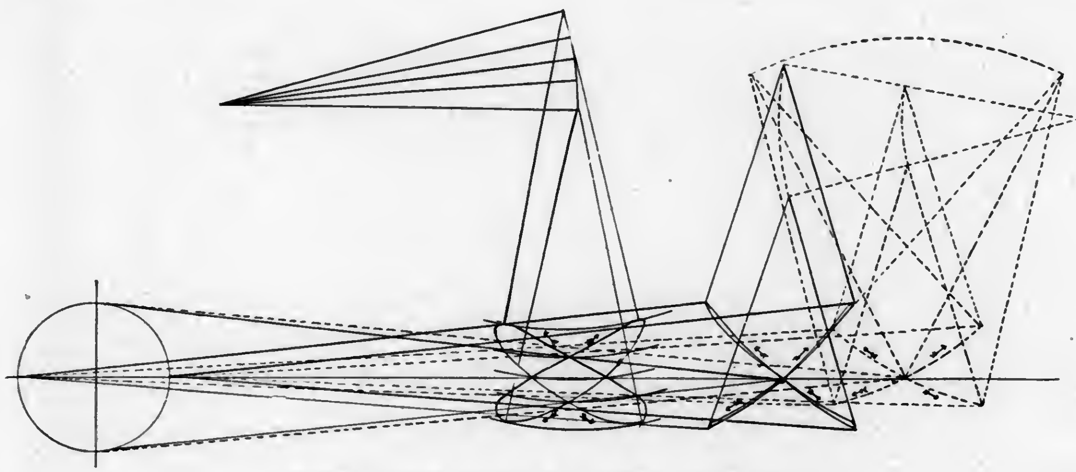
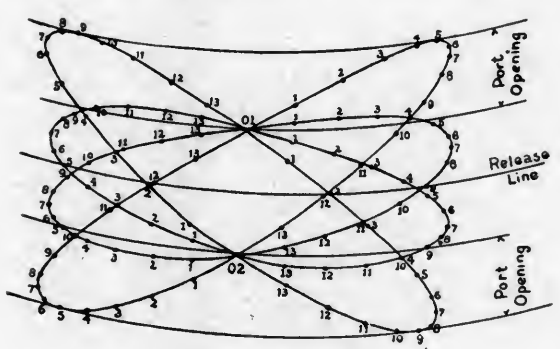


MOTION DIAGRAM OF PILLIOD LOCOMOTIVE VALVE GEAR.

This error was produced by connecting the forward end of the radius link to a reverse of the Marshall type, and has been corrected by the employment of the front rocker arm. An equal travel of the valve is thus secured during each stroke, producing uniform admission and release at each end of the cylinder, and cut-off at equi-distant points. Owing to the employment of the new imparting motion device, the action of the valve is undisturbed and unaffected by vibrations and lateral movement, such as occurs in many other locomotive gears through the yielding of the springs in running over inequalities of the track or in rounding curves.



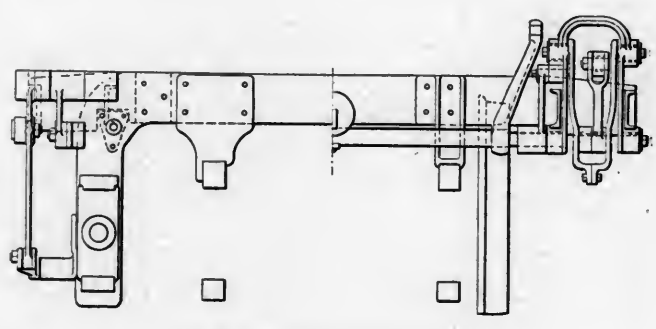
VALVE GEAR ELLIPSE.

The claim advanced for this gear is that it can produce a greater refinement in steam distribution than has heretofore been accomplished, implying a uniform port opening at all points of cut-off, either forward or backward, together with uniform cut-off, uniform release, 25 per cent. cut-off, with a 75 per cent. release, and a late release in the working notches of the quadrant.

The absence of large or flat wearing parts in a valve gear is appreciated by those charged with the upkeep, and in this gear, as in several others, all wear is taken by pin connections, which may be casehardened and replaced when necessary at a minimum of expense. The absence of any great weight in the moving parts also tends to reduce the effect of wear, and at the same time this feature adds to the ease with which the locomotive is controlled from the cab.

In the case of a gear which necessitates the use of a link, errors due to lost motion are often not corrected for long periods owing to the difficulty of making some of the adjustments, while in the case of a gear without wearing parts, other than pins, a correction is so easily made by the adjustment of tapers, or by the insertion of new parts, that the general performance of the engine should be more or less distinctly benefited in the average.

TELEPHONES ON THE QUEEN AND CRESCENT.—The telephone is to take the place of the telegraph on one of the most important sections of the Queen and Crescent route between Cincinnati and Chattanooga, according to announcement, made recently by General Manager Horace Baker. On the 137 miles between Danville, Ky., and Oakdale, Tenn., the installation of a system for dispatching trains by telephone has been authorized and will be put into use as soon as completed.



CROSS SECTION THROUGH YOKE.

WORK ON THE PENNSYLVANIA STATION in New York was started May 1, 1904, so that practically six years and seven months were consumed in making the excavations for the foundation of the building and in constructing it. To clear the eight acres of ground occupied by the station meant the razing of some five hundred buildings, among which were a number of churches.

THE EIGHTH ANNUAL MEETING OF THE RAILWAY STOREKEEPERS ASSOCIATION will be held at Milwaukee, Wis., on May 22, 23 and 24, 1911.

ELECTRICALLY OPERATED TURNTABLES

If a new enginehouse containing more than ten stalls was erected which did not include a turntable operated by power in some manner it would be a subject of very decided comment and surprise to all who visited it. If power operated turntables are of sufficient advantage to be installed in new structures, they certainly are of equal, if not more, advantage at terminals erected a number of years ago. Power equipments for this purpose are practically all designed and suited for easy application to existing hand operated turntables and a few moments' calculation would quickly show that at any busy house, in addition to the advantages of more rapid and positive operation, there is also a very satisfactory money saving to be gained by such application.

At practically all enginehouses of any importance electric current is available and in such cases the electric tractor can be used. A complete equipment of this kind, including installation, costs about $1,500. To hand operate a turntable requires at least two men (sometimes 15 or 20) and the expense for this labor at 15 cents per hour, 24 hours per day, amounts to $2,628 a year. With an electrically operated turntable one man at 15 cents an hour is required, his wages coming to $1,314 per year. The current for this operation will average about $8 per month, or $96 per year, and a charge of 12 per cent. on the original cost will cover the interest and maintenance charges and amount to $180 per year, or a total yearly cost for the electric operation of $1,590, a saving of $1,038 per year on the operation, and that on the basis of only two men for the hand operated table.

ELECTRIC TURNTABLE TRACTOR—CAB IS AT THE CENTER OF THE TABLE.

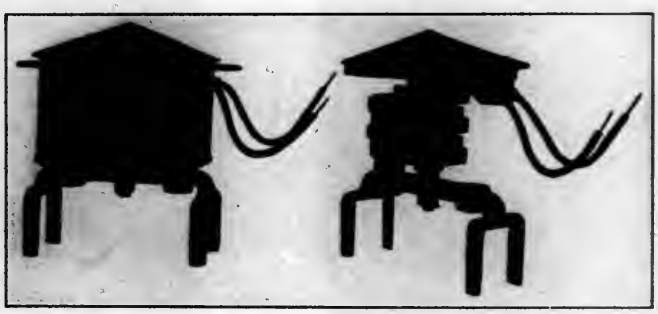
Of course, at points where the electric current is not obtainable a gasoline motor or air motor tractor can be used and will probably show practically as large a saving.

For electric operation the tractor generally consists simply of a very heavy cast iron frame in which is mounted a single double flange steel tired wheel that is driven by a motor through double reduction gearing, the motor being mounted on the same frame. A powerful brake and sanding apparatus also forms part of the equipment. This tractor is attached to the table by a hinged joint connection, which not only minimizes the jar to it, when a locomotive is run on and off the table, but also permits the table to be balanced and offer the least resistance while the tractor clings close to the driving rail and is given sufficient adhesion by its own weight.

ELECTRIC TURNTABLE TRACTOR WITH CAB REMOVED.

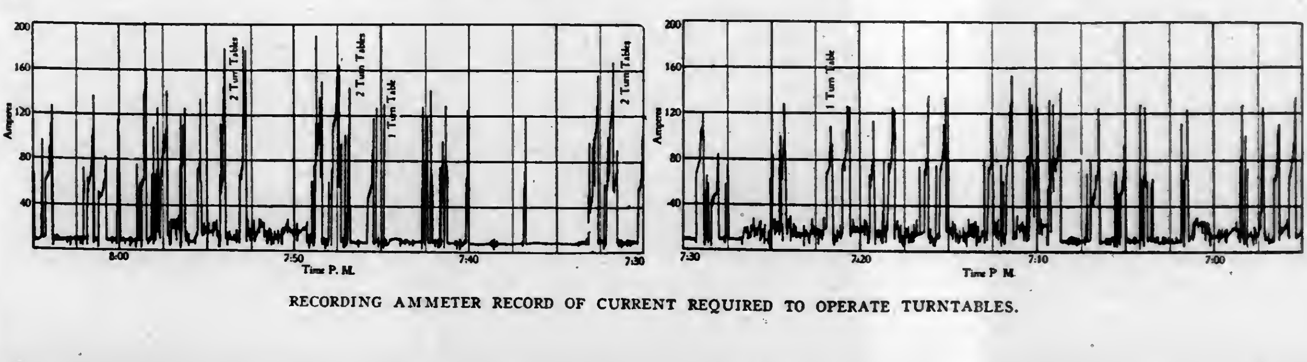
From the motor are carried the leads to the controller, which is located in a cab that can be placed on the table or tractor as desired. With short tables this is sometimes located in the center, mounted directly upon the turntable itself, this location being chosen because of the minimum jar to the operator and equipment. Probably the most suitable location, however, is to mount the cab directly on the tractor, permitting the operator to have a close view of the lining up of the track rails. The controller is somewhat the same as that used on street cars, and does not require the services of an expensive operator.

For entirely satisfactory operation a motor that is properly designed and suitable for frequent starting, capable of withstanding large momentary over-loads, is a necessity. Where direct current is used these conditions are well met by a series wound railway type of motor, and in case of alternating current installation a polyphase slip ring induction motor is best suited. The size of the motor is, of course, dependent upon the weight and rolling friction of the table as well as its diameter and it is seldom that less than a 15 h.p. motor is to be recommended. Often motors of 20 and 30 h.p. are specified. Tractors using both types of motors, as designed and built by the Westinghouse Electric & Mfg. Co., are shown in the accompanying illustration.



COLLECTOR FOR OLD TURNTABLES.

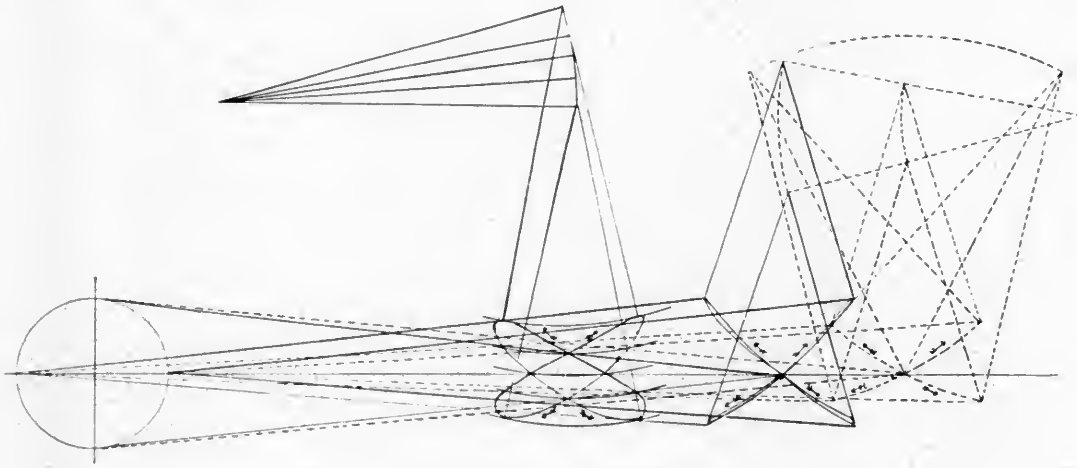
A recent test made with a graphic recording meter placed in the main feeder circuit of three 23 h.p., 220 volt, direct current series motors, each operating a 70 ft. turntable, indicates the



RECORDING AMMETER RECORD OF CURRENT REQUIRED TO OPERATE TURNTABLES.

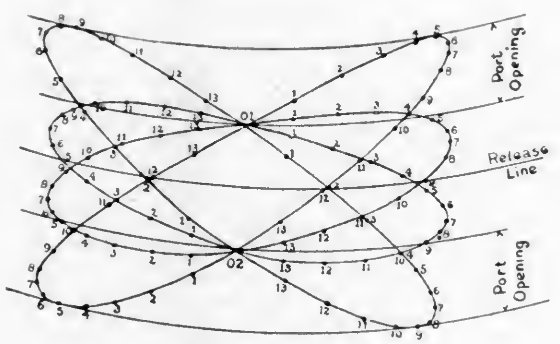
and backward motions. It should therefore follow that with the two extreme positions in harmony the intermediate positions will show corresponding harmonization.

Heretofore when the valve actuating mechanism has been connected to the eccentric arm at a point intermediate with the ends thereof by a pivot traveling in an elliptical path, the forward end of the eccentric arm has always traveled in a fixed arc or accurate path, and the ellipse described by the intermediate pivot connected with the valve actuating mechanism has always been irregular, being greater at the top than on the bottom, and causing unequal valve travel and consequent unequal distribution of steam.



MOTION DIAGRAM OF PILLIOD LOCOMOTIVE VALVE GEAR.

This error was produced by connecting the forward end of the radius link to a reverse of the Marshall type, and has been corrected by the employment of the front rocker arm. An equal travel of the valve is thus secured during each stroke, producing uniform admission and release at each end of the cylinder, and cut-off at equi-distant points. Owing to the employment of the new imparting motion device, the action of the valve is undisturbed and unaffected by vibrations and lateral movement, such as occurs in many other locomotive gears through the yielding of the springs in running over inequalities of the track or in rounding curves.



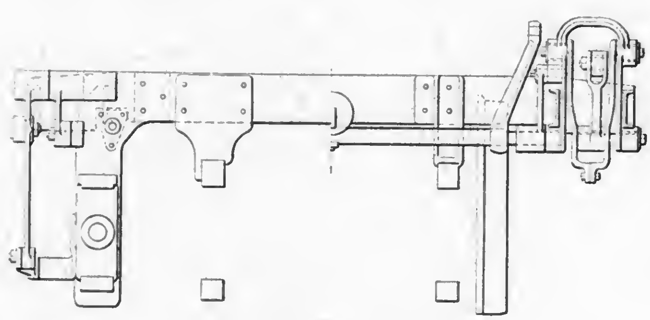
VALVE GEAR ELLIPSE.

The claim advanced for this gear is that it can produce a greater refinement in steam distribution than has heretofore been accomplished, implying a uniform port opening at all points of cut-off, either forward or backward, together with uniform cut-off, uniform release, 25 per cent. cut-off, with a 75 per cent. release, and a late release in the working notches of the quadrant.

The absence of large or flat wearing parts in a valve gear is appreciated by those charged with the upkeep, and in this gear, as in several others, all wear is taken by pin connections, which may be casehardened and replaced when necessary at a minimum of expense. The absence of any great weight in the moving parts also tends to reduce the effect of wear, and at the same time this feature adds to the ease with which the locomotive is controlled from the cab.

In the case of a gear which necessitates the use of a link, errors due to lost motion are often not corrected for long periods owing to the difficulty of making some of the adjustments, while in the case of a gear without wearing parts, other than pins, a correction is so easily made by the adjustment of tapers, or by the insertion of new parts, that the general performance of the engine should be more or less distinctly benefited in the average.

Telephones on the Queen and Crescent.—The telephone is to take the place of the telegraph on one of the most important sections of the Queen and Crescent route between Cincinnati and Chattanooga, according to announcement, made recently by General Manager Horace Baker. On the 137 miles between Danville, Ky., and Oakdale, Tenn., the installation of a system for dispatching trains by telephone has been authorized and will be put into use as soon as completed.



CROSS SECTION THROUGH YOKE.

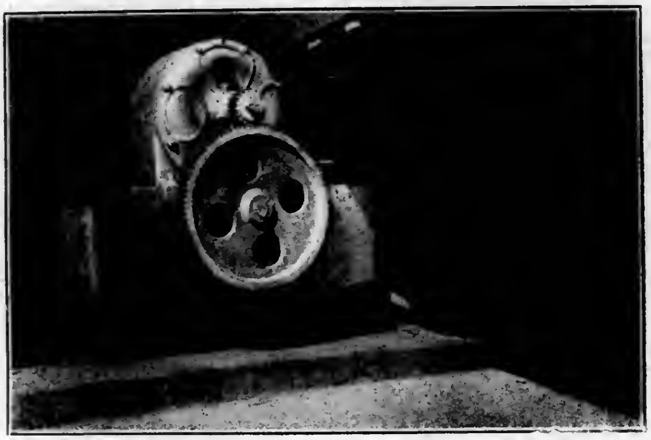
Work on the Pennsylvania Station in New York was started May 1, 1904, so that practically six years and seven months were consumed in making the excavations for the foundation of the building and in constructing it. To clear the eight acres of ground occupied by the station meant the razing of some five hundred buildings, among which were a number of churches.

The Eighth Annual Meeting of the Railway Storekeepers Association will be held at Milwaukee, Wis., on May 22, 23 and 24, 1911.

ELECTRICALLY OPERATED TURNTABLES

If a new enginehouse containing more than ten stalls was erected which did not include a turntable operated by power in some manner it would be a subject of very decided comment and surprise to all who visited it. If power operated turntables are of sufficient advantage to be installed in new structures, they certainly are of equal, if not more, advantage at terminals erected a number of years ago. Power equipments for this purpose are practically all designed and suited for easy application to existing hand operated turntables and a few moments' calculation would quickly show that at any busy house, in addition to the advantages of more rapid and positive operation, there is also a very satisfactory money saving to be gained by such application.

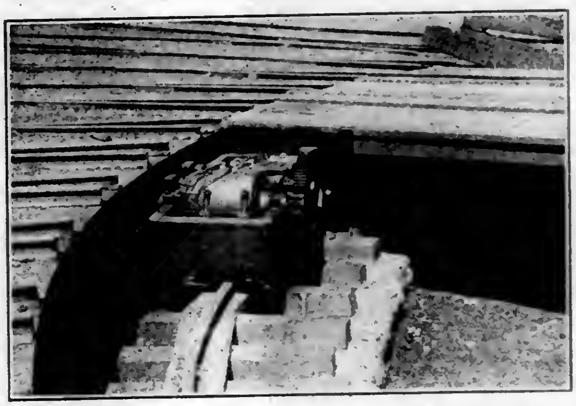
At practically all enginehouses of any importance electric current is available and in such cases the electric tractor can be used. A complete equipment of this kind, including installation, costs about $1,500. To hand operate a turntable requires at least two men (sometimes 15 or 20) and the expense for this labor at 15 cents per hour, 24 hours per day, amounts to $2,628 a year. With an electrically operated turntable one man at 15 cents an hour is required, his wages coming to $1,314 per year. The current for this operation will average about $8 per month, or $96 per year, and a charge of 12 per cent. on the original cost will cover the interest and maintenance charges and amount to $180 per year, or a total yearly cost for the electric operation of $1,590, a saving of $1,038 per year on the operation, and that on the basis of only two men for the hand operated table.



ELECTRIC TURNTABLE TRACTOR—CAB IS AT THE CENTER OF THE TABLE.

Of course, at points where the electric current is not obtainable a gasoline motor or air motor tractor can be used and will probably show practically as large a saving.

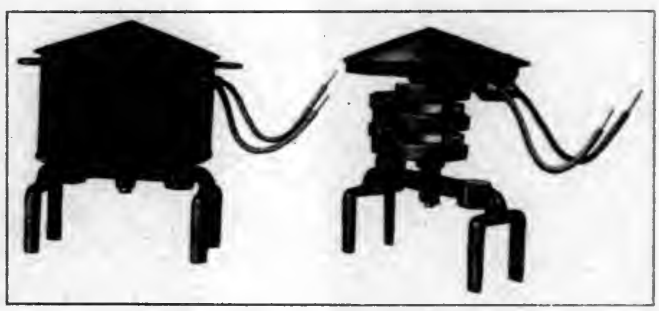
For electric operation the tractor generally consists simply of a very heavy cast iron frame in which is mounted a single double flange steel tired wheel that is driven by a motor through double reduction gearing, the motor being mounted on the same frame. A powerful brake and sanding apparatus also forms part of the equipment. This tractor is attached to the table by a hinged joint connection, which not only minimizes the jar to it, when a locomotive is run on and off the table, but also permits the table to be balanced and offer the least resistance while the tractor clings close to the driving rail and is given sufficient adhesion by its own weight.



ELECTRIC TURNTABLE TRACTOR WITH CAB REMOVED.

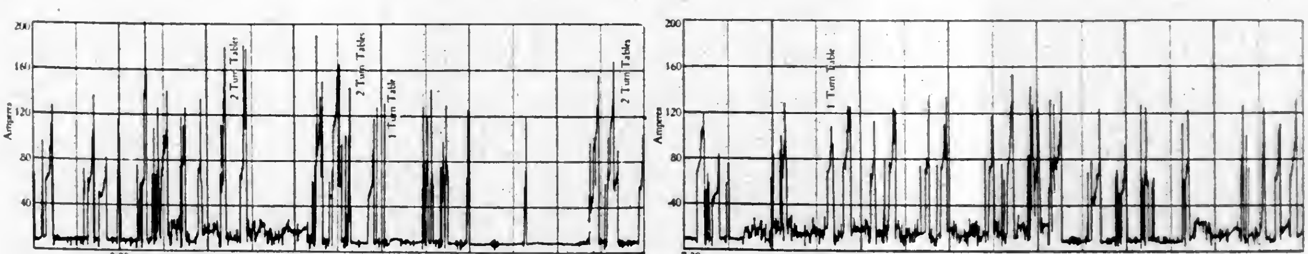
From the motor are carried the leads to the controller, which is located in a cab that can be placed on the table or tractor as desired. With short tables this is sometimes located in the center, mounted directly upon the turntable itself, this location being chosen because of the minimum jar to the operator and equipment. Probably the most suitable location, however, is to mount the cab directly on the tractor, permitting the operator to have a close view of the lining up of the track rails. The controller is somewhat the same as that used on street cars, and does not require the services of an expensive operator.

For entirely satisfactory operation a motor that is properly designed and suitable for frequent starting, capable of withstanding large momentary over-loads, is a necessity. Where direct current is used these conditions are well met by a series wound railway type of motor, and in case of alternating current installation a polyphase slip ring induction motor is best suited. The size of the motor is, of course, dependent upon the weight and rolling friction of the table as well as its diameter and it is seldom that less than a 15 h.p. motor is to be recommended. Often motors of 20 and 30 h.p. are specified. Tractors using both types of motors, as designed and built by the Westinghouse Electric & Mfg. Co., are shown in the accompanying illustration.



COLLECTOR FOR OLD TURNTABLES.

A recent test made with a graphic recording meter placed in the main feeder circuit of three 23 h.p., 220 volt, direct current series motors, each operating a 70 ft. turntable, indicates the



RECORDING AMMETER RECORD OF CURRENT REQUIRED TO OPERATE TURNTABLES.

amount of power that is absorbed by one of these motors at the instant of starting. On this diagram the record shows where two and sometimes three tables were in use simultaneously. It will be seen that a loaded 70 ft. table requires about 120 amperes at the moment of starting, this, however, falls almost immediately to half this amount to keep the table in motion.

For supplying the current to new installations it has been customary to have a contactor at the center pin and connect the power circuit to it underground. This, of course, is advisable in all cases where possible, but in application to existing equipment it is often impossible and in such cases the best scheme is probably the use of an overhead contactor that is supported by a framework in the center of the table. These collectors have been refined after long experience and a very successful arrangement is shown in one of the illustrations.

AN INGENIOUS AIR DRILL PRESS FOR TOOL ROOM WORK

This compact air drill press was built and installed in the tool room of the Winona shops, Chicago and Northwestern Ry., and is said to be the most useful and busiest machine in that department. Its construction is clearly indicated in the drawing, Fig. 1, and it can be built of any size most convenient, but in this instance the cast iron round base (A) is 14 in. in diameter and 1½ in. thick. Although the drawing lacks dimensions, they can be closely approximated with this as a basis.

The plate (A) which serves in the double capacity of drill press base and table, has two brackets (B) which support the 1⅜ in. vertical columns (C). The operating handle (D) is pivoted at (E) to (I) and with it the operator feeds the drill. (I) is split part way and bored out to fit the column (C). A set screw (G) is screwed through the split portion and is loosened or tightened by the small lever (F) on its head. This permits the drill to be raised or lowered to suit the work and

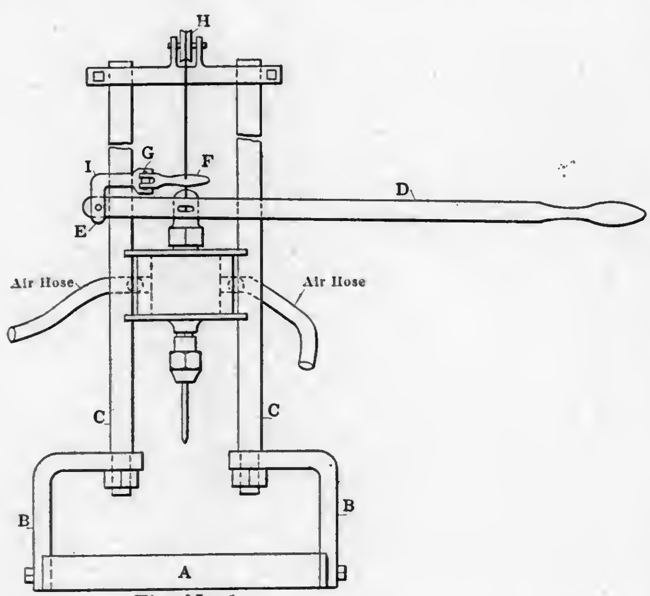


Fig. No. 1

tightened to the column. (H) is a sleeve over which a cord travels to a weight to counterbalance the air motor.

If a Little Giant tell-tale motor cannot be obtained a suitable air motor is suggested in Fig. 2 in which (G) is a cast iron body, 3 in. inside diameter, with a partition (H) and heads (I). Within are two rotating pistons (A) mounted on a shaft (B) in the heads (I), out of center. (D) are packing strips, and (C) the springs which hold them out against the cylinder wall. (E) are also packing strips inserted in the cylinder body extension, which latter is cast integral with the cylinder body, and the springs (F) keep the strips (E) tight against the circumference of the pistons.

Railways in China.—Ten years ago there were not five miles of railway in operation throughout the entire length and breadth of the vast empire of China; to-day something like 5,000 miles of railway are open to traffic or in course of construction. No longer are the people of China hostile to railway projects in any part of the country; their eagerness to have them, indeed, is only bounded by want of capital to construct them, and, here and there, an intense reluctance to borrow foreign capital on the terms capitalists consider will adequately guarantee the safety of their funds.

We Find It Desirable in the Purchase of Material to keep in mind the manufacturers located on our own lines, and other things, such as price, quality and delivery being equal, to give them the preference. The difficulty of this problem is to determine when other things *are* equal. A similar difficulty arises when in the purchase of new cars or locomotives we are called

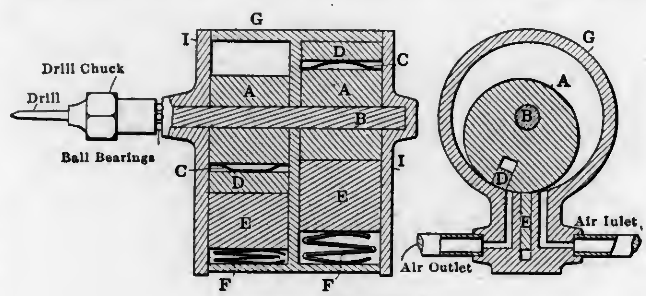


Fig. No. 2

upon to make a selection of specialties, and we have to determine for instance, whether we shall continue the use of a certain device which we know is good, or try one which looks good and is offered at a lower price.—*F. H. Clark before the University of Illinois.*

New Car Shop for the Pennsylvania Railroad.—On account of the increasing demand for all-steel cars, the Pennsylvania Railroad has authorized the construction of an additional car shop at Altoona, Pa., that will double the capacity of the present one. Work on it will begin at once, and it is expected it will be ready for service in the spring. It will be of galvanized iron on solid steel frame, 90 feet wide and 540 feet long. Steel passenger coaches, baggage and mail cars, diners, steel freight cars and, in fact, every kind of all-steel car, will be manufactured in this plant.

Elevated Road to Carry Freight.—The Boston Elevated Railway Company has explained to the city council of Boston plans it has formulated for carrying baggage and freight if permission can be secured. The erection of a large freight terminal is one of the features of the enterprise. According to the report of the High Cost of Living Commission, the cost of farm products might be reduced to some extent if the produce was sent to Boston on the electric cars.

Non-Shrinking Alloy.—The following receipt for a non-shrinking alloy was recently published in the *Metal Industry*: Tin, 50 pounds, and zinc 50 pounds, gives a tough, hard metal that runs well. It is improved by the addition of 2 pounds of bismuth. By the use of heavy sprues, and by pouring cold, the slight shrinkage may be largely overcome.

High Speed Locomotives

A REVIEW OF THE DEVELOPMENT WHICH THIS TYPE HAS ATTAINED IN VARIOUS COUNTRIES FOR RUNS SCHEDULED AT OVER SIXTY MILES AN HOUR

High locomotive speed is a definition which, when viewed from a personal or a purely local standpoint, becomes largely undefinable. For instance, what may be regarded as high speed on one road, and it can often be so considered when the moderate resources of that road are reckoned with, becomes nevertheless only of the average when contrasted with a road of greater resources. A single track line with grades, sharp curves, and many stops, in connection with a train which averages forty miles per hour, elapsed time, no doubt considers such showing as commendable; whereas, a double track railroad, with a train making no stops over fairly level country, at 55 miles per hour, would be inclined to scoff at the performance of its neighbor. This is an unfortunate but nevertheless true association with American railroads, where conditions operating for and against are too often not taken thoroughly under consideration.

This is why, in the interesting inquiry into high speed possibilities, and into the locomotive development which must necessarily accompany it, that the Eighth Session of the International Railway Congress limited all consideration of the subject to trains whose speed on regular schedules equals or exceeds 62 miles per hour.

One mile in one minute is generaly regarded as the slogan of unusually fast performance, and in thus restricting the figure to that unquestionably high average the Congress placed itself in a position to unearth all that pertains to the requirements of excessive speed. This ruling would have operated seriously against securing statistics from American railroads, which heretofore in compiled form have been lacking, had it not been for the wise decision of William Garstang, the American reporter, who urged upon the Congress the necessity for reference to all speeds over fifty miles per hour, this latter figure being more nearly the exponent of high speed in this country than the somewhat excessive limit determined upon by the Congress.

The inclination of the traveling public, although its wishes and expectations are often beyond existing possibilities, has ever tended in the direction of fast time, and notwithstanding the poor economy which this operation implies, or is said to imply, it has become apparent that its wishes can no longer be denied. Independent of this important factor in the consideration, sustained high speed has always been of unusual interest and fascination to railroad men of the entire world, no doubt because they are well acquainted with the difficulties which must be overcome, and because these difficulties themselves act as a stimulant towards the effort to overcome them. Extremely high speeds, that is, those employed in regular scheduled runs of 60 miles an hour and over, impose many intricate problems upon the locomotive designer, and necessitate a refinement in development along certain lines which at slower speeds is not so important.

Locomotive design for such exacting service has been a question considered several times by the International Railway Congress. At the London session in 1895 it appeared as question "VI.," "Express Locomotives," and at the next session at Paris in 1900, question "XII." carried a very similar title, "Locomotives for trains run at very high speed." At the session in Washington, D. C., 1903, the subject was again discussed, but not limited as before to fast locomotives only, as question "V." on that occasion was entitled "Locomotives of great power." Although this definition includes great tractive effort rather than high speeds, still the reports submitted also gave particulars of a number of notable express locomotives.

Before proceeding with the subject of locomotive design on roads and in countries where a speed of 60 miles an hour is regularily employed, it is fitting to say that this speed is far from being so fully identified with practices in the United States as it is abroad. Except in the instance of two roads, one of 55 and the other of 59 miles, no runs are scheduled at that rate, although the time, of course, is made and exceeded on roads all over the country every day. Hence the question put by the American reporter to six of the most prominent railroads was modified as follows: "Do you own or operate steam locomotives which in regular service are required to transport trains at speeds of 50 miles per hour or more?" This implies a reduction of ten miles in the instance of the similar question put by the foreign reporter, A. Courtin, to the railroads of all countries except America.

Obstacles to Sustained High Speed.

It is quite evident from a casual study of the situation that had the question been submitted by the American reporter in the original form proposed by the Congress the replies would have been practically negative in yielding any information. Locomotive designers for the past twenty years in this country have not been aiming at speed alone, nor speed and power combined, but speed, power and reliability. This presents the real difference between our own and foreign practice, where strenuous efforts have been made to cut down the time with trains of existing weight.

High speed trains within the scope of the question, as applied to American practice which is now under consideration, are ordinarily composed of from 6 to 8 cars, and taking the average at 7, with a loaded weight of 59.5 tons, the average weight of high speed trains in this country becomes 416.5 tons. The average length of cars over the faces of couplers is 78 feet, thereby making the length of the average 7 car train 546 feet from the face of the coupler to the rear of the tender. These representative weights and lengths have been very carefully averaged from Mr. Garstang's admirable report to the Railway Congress.

An analysis of the reports from foreign roads indicate a general lighter average weight, but the difference is not so marked as is popularly supposed. The highest figures for train weight is about 400 tons, this operated on the Great Eastern Railway, and the Great Western Railway, both of England, and the Orleans Railway of France. The French Eastern Railway approaches this figure closely with 374 tons. With these exceptions the weights of foreign fast trains are variable, but weights of over 300 tons frequently appear. It is therefore thought advisable to make this fact prominent early in this article, as a very common misapprehension exists in this country regarding the presumed lightness of foreign railroad trains.

These weights behind the tender have been practically stationary in foreign countries for a number of years, while in the meantime the locomotives hauling them have increased greatly in speed and power. In this country while the locomotives have maintained a continuous development, the weights behind them have increased in proportion, so in reality no higher speeds, except in isolated instances, are scheduled than were in vogue two decades ago. It is admitted that great changes have been made in the design and construction of English railway carriages, with a corresponding increase in unit weight, but the number of train units has been reduced, and the total train weight will show little variation when compared with the figures of past years.

In the comparison between high speed locomotives at home and abroad it is also well to bear prominently in mind the difference in the geographical conditions of the contrasted railways, which necessarily has a vital bearing on the question. American roads are operated through territory that provides all the natural obstacles which the world affords, and the char-

acteristics of the country through which certain lines have been laid taxed the skill of the locating and construction engineers to its utmost, but the fact remains that elevations from sea level 6,000 feet have been surmounted. Districts of a mountainous character entail a succession of curves of small radii, which considerably add to train resistance in excess of the grades on which they may be located. The duty of the American locomotive at such points is not measurable in the reports submitted to the Congress, as there are no comparative foreign conditions to make this possible.

THE 4-4-2 AND 4-6-2 TYPES NOW STANDARD.

The present design of American locomotives for high speed work requires boiler pressure varying from 180 to 225 pounds per square inch, the boiler being exclusively of the fire tube type and generally with a round top. All locomotives have outside cylinders whose axis is parallel with the top of the rail, and approximately 1½ inches above the center of the main axle. For the fastest trains the Atlantic, or 4-4-2 type is favored, although there are examples of the 4-6-2, or Pacific type, in high speed service. For steam distribution the Stephenson link motion is largely employed, but the tendency of late has been towards the Walschaert gear, which has all the characteristics of that used in European continental practice, with some slight variations to adopt it to certain features in American construction. There is a marked tendency toward discontinuing the compounding of locomotives in districts where fuel is cheap, and also where the added maintenance cost more than offsets the gain in compounding. Superheaters are used to a limited extent, but no general conclusions whether for or against have been reached as yet.

Reports received from six large railway systems of the United States to whom the question was referred indicate that all locomotives in fast train service are single expansion Atlantics or Pacifics, and all use non-superheated steam. All but two of the eight locomotives covered in the reports have piston valves, and the valve gear is Stephenson for the 4-4-2 and Walschaert for the 4-6-2 type.

It is to be regretted that no conclusions have been reached to demonstrate the relative merits of these two valve gears, as there is a marked tendency on the part of some American designers to use the Walschaert in recent construction, notwithstanding the fact that all but two of the class of high speed engines reported on as representing American practice have their valves operated by the Stephenson shifting link gear. In the opinion of the American reporter the Walschaert gear can be commended solely from the standpoint of easy inspection and maintenance, and not for superiority in steam distribution. Mr. Garstang advances the logical argument that as a locomotive might be employed to transport trains at high speed in one direction over a division, with a return trip frequently in local service, this state of affairs requires it to be run at constantly varying piston speeds, and it is a well known fact that constant lead valve gears are not adapted to these variations of piston speeds. The American reporter contends that the shifting link gear, while embodying inherent defects, nevertheless readily adapts itself to variable piston speeds in such a manner that it will give considerably better service from a standpoint of steam distribution than the Walschaert, since the latter is an invariable quantity so far as angular advance necessary to high piston speeds is concerned. The fact remains, in support of these contentions, that 75 per cent. of the American high speed engines reported on embody the Stephenson gear, as indicated in the tabulated summary below of principal items of construction.

The general use of the steam engine indicator on locomotives in regular service has thoroughly demonstrated that a port opening for admission, amounting to 0.25 inch at the extreme ends of the stroke has been found ample to supply steam at the most economical points of cut-off and high piston speeds. It would probably be more advantageous in preventing wire drawing to secure an opening of 0.3125 inch. This, however, makes it necessary, when using the Stephenson link gear, to resort to negative lead in backward motion at full stroke, and the amount of negative lead must be governed by the stroke of the engine on which it is used, as its purpose is to reduce pre-admission to the minimum in order to provide the necessary mid-gear lead above referred to. This applies alike to all Stephenson shifting link gears, irrespective of whether the motion is coupled direct or indirect, or whether the valves are of the flat slide or piston type.

It is desirable that in locomotives intended for high piston speeds that all counter-pressures should be eliminated to the greatest possible extent, and with pre-admission beginning at a point not greater than 1 inch before the end of the stroke is reached, and the release occurring after the crank pin has traversed not to exceed 135 degrees of its path, the most advantageous conditions are obtained. To this end "exhaust clearance" must be resorted to, and the amount of such clearance is to be regulated entirely by the valve travel and stroke of the engine. Constant lead gears with stationary links on the Walschaert principle, and designed for high speed locomotives must necessarily be required to provide the same conditions as noted above, and if possibilities of design will admit of these conditions, then no further comment is necessary from a standpoint of criticism of the Walschaert type, except to say it is deficient in meeting the most consistent requirements of variations in piston speeds over or under that particular speed for which the motion is primarily designed.

The piston stroke reported was 26 inches for the 4-4-2 and 28 inches for the 4-6-2. All of the 4-4-2 type have cylinders varying from 20 to 21 inches in diameter, and for the 4-6-2 a diameter is reported of 22 inches. Working pressures vary from 185 to 210 pounds per square inch, the general range being from 200 to 205 pounds gauge pressure The driving wheels vary from 78 to 80 inches in diameter, over the tire, and the weight (locomotive only) in working order from 180,000 to 190,000 pounds for the 4-4-2, and 262,000 to 266,000 pounds for the 4-6-2 type. The weight on driving wheels is from 81,200 pounds to 118,340 pounds for the 4-4-2, and averages 192,000 pounds for the 4-6-2 type.

COMPOSITE FEATURES OF DESIGN.

In the following table, compiled from the lengthy returns of the roads interrogated, an interesting summary of averages is afforded of the most important items entering into the construction of the locomotives reported on. It is offered as a composite result which embodies an average of the six Atlantics and two Pacific types falling under the scope of the 50 miles per hour question, and may be regarded as practically conclusive in indicating the general trend of American high speed design.

General name of class	Atlantic	Pacific
Wheel distribution (locomotive only)	4-4-2	4-6-2
Weight on driving wheels (working order) lbs.	106,468	173,750
Working pressure, by gauge, lbs.	201	200
Diameter of cylinders, inches	21	22
Stroke of cylinders, inches	26	28
Type of valves for steam distribution	Piston	Piston
Type of valve gearing	Stephenson	Walschaert
Driving wheels, diameter, inches	79.2	79
Total tractive effort, lbs.	24,268	29,900
Total heating surface, sq. ft.	2,948.2	4,192
Grate area, sq. ft.	51.1	56.6
Ratio of total heating surface to grate area	58.33 to 1.00	74.10 to 1.00
Ratio of heating surface to cylinder volume	512 to 1.00	342 to 1.00
Capacity of tender, gallons	6,700	8,000
Average speed required to maintain schedule, miles	55.26	55.85
Average weight of train, tons	344.88	452
Average number of miles made without stops	100	160

The above composite table represents the evolution of fundamentals in locomotive design, of which the following tabulation embodies the most significant items. In it the conclusions reached on the testing plants of Purdue University and of the Pennsylvania Railroad are also carefully averaged, and they may be regarded as the basic data for the design of the representative high speed locomotives which have been described:

BOILER PERFORMANCE.

Boiler horse-power per sq. ft. of heating surface	0.40
Weight of steam delivered per hour in pounds per sq. ft. of heating surface	14.00
Per cent. of moisture in steam delivered	1.35
Maximum economical pressure for saturated steam, by gauge, lbs.	200.00
Maximum evaporative efficiency, water per lb. of coal, when power developed is low, lbs.	11.00
Evaporative efficiency, water per lb. of dry coal, when the power developed is greatest, lbs.	7.00
Fire-box temperatures, degs. Fahrenheit, at low rates of combustion,	1,400 to 2,000
Fire-box temperatures, degs. Fahrenheit, at high rates of combustion,	2,100 to 2,300

CYLINDER PERFORMANCE (HIGH PRESSURE.)

Steam consumption per indicated horse-power per hour, average minimum, no superheat, lbs.	24.35
Steam consumption per indicated horse-power per hour, average maximum, no superheat, lbs.	24.40
Percentage of cylinder power appearing as a stress at drawbar, at 40 revolutions per minute	86.00
Percentage of cylinder power appearing as a stress at drawbar, at 280 revolutions per minute	75.00
Piston speed, ft. per min., at which wire-drawing of steam begins..	800.00

RATIOS.

	Atlantic.	Pacific.
Heating surface to grate area	56 to 1.00	72 to 1.00
Heating surface to cylinder volume	275 to 1.00	350 to 1.00
Tractive effort to heating surface	8.60 to 1.00	8.29 to 1.00
Tractive effort to weight on drivers	4.36 to 1.00	4.66 to 1.00
Weight on drivers to total heating surface	3.75 to 1.00	3.86 to 1.00
Grate area to cylinder volume	4.55 to 1.00	4.27 to 1.00

What has preceded is about all that can be offered in connection with the American high speed locomotive within the province of this article. It is prominent that an uniformity of design prevails in this country, notwithstanding the diversity exhibited abroad, to the extent that two-thirds at least of certain features have almost come to be regarded as standard practices. These are quite apparent in the above tables.

Further High Speed Development Improbable.

From a careful study of prevailing conditions, and consideration of the opinions which have been reflected from time to time, it may be said that there is little chance for further development of strictly high speed locomotives in this country. While it is realized that the present highest speed averages 55.26 and 55.85 miles per hour, for Atlantic and Pacific types, respectively, could no doubt be improved upon, the fact remains that this improvement must materialize at the expense of possible compounding and vastly increased complexity, features which are viewed with little favor by the men who actually operate engines in the United States.

There is little doubt that compounding which is so successfully used on the continent of Europe for fast train service, failed in this country, not so much through inefficient up-keep, although the latter was prominent, as it did through the indifference or only half-hearted acquiescence of the engineers and firemen. No such attitude towards a new departure is ever encountered abroad. The splendid work of the complicated du Bousquet-de Glehn engines, on the *Chemin de fer du Nord* of France, at speeds averaging over 60 miles an hour, is the reward of painstaking effort in perfecting organization as well as appliances which has extended considerably over a period of twenty years. The men who handle these engines have been well trained. They understand the principle of compounding as there applied, and they are in a position to get the best possible work out of the engines. They are not trying, as indeed it seems was attempted here, to defeat the system, but to assist it, and on a compound engine the sympathetic attitude of the engineer becomes the main factor towards its success.

To properly handle a de Glehn, for instance, many extra demands are imposed on an engineer than American practice affords. In addition to the usual features in connection with cab details in this country there is the variable exhaust, and the independent valve gears for both high and low pressure cylinders, which must be continually readjusted to suit the varying conditions of track and grade. When these parts are, by intelligent handling and co-operation, made to perform the functions for which designed, a very high speed locomotive results with great economy, but when the possibilities are not realized through lack of manipulation, ignorance or prejudice, then the de Glehn becomes practically a failure. Our engineers are more intelligent and much more broadly educated than those in foreign countries, but the latter work faithfully with what is given them and do not condemn a device which may mean a little extra work, and simply on that fact alone.

As not only the speed but also the maximum power of the locomotives is of interest, in connection with foreign practices, a brief review of some of the longest runs, made without a stop, or without change of engines, may be to the point. In the first place, in relation to the longest runs without stops, these amount to from 62 to 124 miles, on half of the sixteen railroads who replied to M. Courtin, the foreign reporter to the Congress. Four other roads give from 124 to 186 miles; two others runs of less than 62 miles, and the remaining two, runs of over 186 miles. The longest run made without a stop anywhere in the world is on the Great Western Railway, from Paddington to Plymouth, or vice versa, 226.5 miles. The Midland railway follows with 207 miles.

The longest runs made without change of engines, are either the same as the non-stop runs, or in some cases considerably greater. The first place is again occupied by the Great Western Railway, which reports Paddington to Weymouth and return, 309 miles. Next comes the Orleans Railway of France, with the Tours-Bordeaux run, 216 miles, and on the Paris-Liege line, 230 miles without change of locomotive.

Among all countries with which this high speed question has to deal, and which are affiliated with the International Railway Congress, it is only in those of Europe that trains are run at a schedule speed of 62 miles an hour (100 kilometers). In Europe, even, such speeds are only attained in regular working up to 80.2 miles per hour on the British and French railways.

Foreign High Speed Locomotives.

The usual arrangement of the locomotives for attaining these high speeds is the 4-4-0, 4-4-2, 4-6-0 and 4-6-2 types. The leading trucks have all more or less lateral play, the return to the central position being insured by such well known means as check springs, swing links, etc. On several English railways the driving axles have also a little lateral play. Two cylinder and four cylinder locomotives are about equally represented, but among those most recently built there are more of the four cylinder construction. Those with three cylinders are used only to a limited extent on two English railways for high speed purposes.

In regard to the cylinder arrangements in the different countries, the two cylinder predominates in England, while but few of these locomotives are used on Belgian, German, French and Swedish railways. In the latter countries the four-cylinder locomotive is decidedly prominent, and particularly in France. The two cylinder locomotives have inside cylinders, only about ten per cent. being reported as having outside cylinders. The four cylinder locomotives have two outside and two inside, without exception. There are no instances of design with cylinders placed one over the other, or one behind the other, and acting on the same crosshead, as in the Vauclain, or in the tandem types.

As far as four cylinder compounds are concerned, the low pressure cylinders are inside and the high pressure cylinders outside, on the majority of the locomotives. The two cylinder locomotives are chiefly non-compounds, but on the contrary compounding predominates in case of the four cylinder locomotives, the only two exceptions being the Belgian State Railway and the Great Western, which are four cylinder simple expansion, using superheated steam.

On the four cylinder locomotives the connecting rods either all act on the same driving axle, as a rule, the first; or those of the inside cylinders act on the first, and those of the outside cylinders on the second, the two being connected by coupling rods. This latter, or de Glehn design, is used on all the French, some of the Danish, and on one of the English four cylinder arrangements, while the single axle drive is found on the Belgian, German, Italian, Hungarian and one of the English locomotives. The average diameter of driving wheels, as deduced from returns on 26 engines, each scheduled to run at 62 miles per hour or more, is found to be 79 inches, singularly enough an exact approximation to United States ideas, and only one of the very few of such parallels which are in evidence.

Superheaters Becoming More Popular Abroad.

Low steam pressures of from 147 to 175 pounds are only apparent in a few cases; medium pressure of 190 and 205 are more frequent, particularly in the case of English locomotives, where 185 pounds per square inch is the rule. The highest pressures of 220 and 225 pounds are found on nearly all of the French and German locomotives, and also on those of Belgium Denmark, Italy and Hungary.

The older wet steam principle is the rule, superheated steam locomotives forming the exception. Taking it altogether, only two Belgian, four German, one English and one Swedish superheated steam locomotive were reported to the Congress, although several roads are at this time considering the advisability of applying superheaters to high speed engines. The German superheated steam locomotives are all four cylinder compounds. All other superheaters are non-compounds, and have either two cylinders or four.

As regards size, boilers have a heating surface of from 1,614 square feet to 2,691 square feet. Small boilers, with heating surfaces down to 1,076 square feet, are rare exceptions. The grate area varies considerably, no doubt being much influenced by the quality of the coal. This is illustrated by the comparatively small grates of the English locomotives, and of some Continental locomotives which burn English coal. The length of grate on the large majority of locomotives does not exceed 8 ft. 2 7/16 in., and grates longer than 9 ft. 10 in. are only found in very few cases. When a larger grate is required the plan generally adopted is to have a wider fire-box, either standing on the frame between the wheels, or also extending beyond them.

The weights of locomotives in working order vary much according to design. The lowest figure is 94,800 pounds for the 4-4-0 two cylinder locomotive of the French Northern Railway, and the highest is 199,300 pounds for the 4-6-2 four cylinder locomotive of the Midi Railway. The adhesive weights in the case of locomotives with two driving axles are between 63,050 and 87,740 pounds. In the case of locomotives with three driving axles the lowest adhesive weight is 93,630 pounds, and the highest 122,350. Axle loads of less than 33,100 pounds are found only in a very few cases. The majority of the locomotives have axle loads on driving axles of from 35,270 to 39,680 pounds. The maximum, about 44,100 pounds, is found on the 4-4-0 locomotive of the Midland Railway of England.

Tenders with three axles predominate. The Danish and German, with a few English and French locomotives, have the four axle arrangement with, as a rule, two trucks, the only exception, in fact, being the Danish four wheel tender, which has all the axles in one common frame, and with lateral play in the instance of the first and third axles. The water tanks are of the usual rectangular or horseshoe type. The Hungarian 4-4-2 four cylinder compound is the only one equipped with a Vanderbilt tender.

The great majority of the tenders take 3,300 to 4,500 gallons of water, the latter being the usual figure in the instance of the most recent tenders. The greatest capacity is found on a four-axled tender of the Bavarian State Railway, which has a capacity of 5,720 gallons. Water scoops are found in a few cases on French and English tenders. The coal capacity of the tenders is from 11,030 to 13,230 pounds. The tender of the 4-4-0 locomotive of the Great Eastern Railway, which is designed for supplementary oil firing, can take 3,360 pounds of coal and 715 gallons of liquid fuel.

Corresponding to the increase in capacity of tenders which in the last few years has taken place abroad, the increase in weights has been considerable. In most cases the weight varies between 77,200 and 99,200 pounds, but a very appreciable number of tenders are heavier, and the weight in running order attains a maximum of 127,650 pounds. If the weight of the tender empty be compared with the quantity of water it can hold, it will be found that the old rule, according to which the weight of the tender, empty, is about equal to the weight of the water it takes, is still generally applicable to tenders on foreign roads.

Great Variation in Foreign Practices.

These are the principal features in the construction of foreign high speed locomotives and it will be noted that they are at such variance with one another that it would scarcely be possible to average the types after the manner in which the chief characteristics of the American locomotives was presented. A merely superficial study of old world conditions in this regard would readily convince that every road is working out its own independent ideas, and without scarcely even the effort to learn what is being done elsewhere. In consequence certain details of construction, which are now practically standardized in the United States, will be found different on every railroad of Europe, and, if possible to approach the subject closely, a good reason will be advanced by those in charge why they should be different. Some of the details are worthy of consideration.

In spite of the great number of revolutions per unit of time which the driving wheels of the locomotives can attain at high speeds the flat slide valve still retains its position. It is still used in its simplest form, not balanced, on some of the French and English locomotives, for instance those of the Paris-Lyons-Mediterranean Railway, and not balanced in connection with the low pressure cylinders of the locomotives of the French State Railway. The non-balanced flat slide valve can also be found in England on the Great Central Railway, the Great Eastern, the Midland, the Lancashire and Yorkshire, and the South Eastern and Chatham Railway.

Balanced flat slide valves are used on the Baden State Railway, on its 4-4-0 and 4-4-2 classes; on the French Northern, low pressure cylinders of the 4-4-2, and all cyliners of the 4-6-0 type, and on the Midi Railway, of France, in the high pressure cylinders of the 4-6-2 locomotive. The balancing device of the Baden State has a coned ring which is automatically applied by the pressure of the steam. In this case the valve, balance plate and cone rings are made of cast iron. Bronze, however, is generally favored for both balanced and non-balanced flat slide valves. The balanced slide valve on the Lancashire and Yorkshire is merely that of our own practice in the United States, and the same general arrangement is followed on the railroads of France. In addition to the slide valve, piston valves are also to be found, particularly in the case of the more recent locomotives. These are of varying design, and are used for both high pressure and low pressure cylinders.

The question of piston speeds is of interest. At a speed of 62 miles per hour it is found to vary between 16 ft. 7¼ in., to 23 ft. 8 5/16 in. per second, the lower limit applying to the 4-4-0 locomotive of the Baden State Railway, with two inside cylinders, and the higher to the 4-4-2 tank locomotive of the Great Western Railway. No well defined or even approximate relation between piston speeds and the design of the locomotives, for instance, according to position and number of cylinders, can be determined. On the contrary, comparatively high piston speeds, of 16 ft. 5 in., to 19 ft. 8 in. per second, when the train speed is 62 miles an hour, are observed both in the case of locomotives with two outside cylinders, and in that of locomotives with inside cylinders; while, on the other hand, lower piston speeds, hardly exceeding 16 ft. 5 in. per second, are even found in the case of four cylinder locomotives with pistons moving in the opposite direction to each other.

No Uniformity in Fundamental Design.

The maximum piston speeds are attained on the one hand by the 4-4-2 locomotive of the Belgian State Railway, which has only two outside cylinders of 20 ft. 7⅝ in. per second, at 68.4 miles per hour; and, on the other hand, by the 4-4-0 locomotive of the French Northern Railway, which has four cylinders and pistons moving in the opposite direction with each other, of 25 ft. 6 in. per second, when running at 74.5 miles per hour. The highest piston speed, 30 ft. 2⅝ in., is that of the 4-4-2 tank locomotive of the Great Western, which has outside cylinders, and runs at 80.2 miles per hour.

An analysis of the figure for driving wheel revolutions shows a much smaller difference than those for piston speeds, and in this case also no definite or approximate relation between the number of the revolutions and the design of the locomotive can be found. The number of revolutions corresponding to a speed of 62 miles an hour varies between 240 and 195 per minute. The absolute maximum of 364 revolutions per minute is attained by the 4-4-0 locomotive of the French Northern, when running 74.5 miles per hour. The figures for the revolutions of the carrying wheels show much greater differences than in the case of the driving wheels. For leading truck wheels they vary between 409 and 624 per minute. As regards trailer carrying wheels,

which, as a rule, are of quite large diameter, the number of revolutions is, of course, much smaller.

The balancing of the moving masses, both of the eccentrically-placed rotating masses and of the reciprocating masses, in so far as these are at all balanced, is in all cases effected by balance weights which are applied in the well known way to the wheels. However, while the rotating masses are balanced completely everyhere, matters are quite different so far as the reciprocating masses are concerned. Considering in the first place locomotives with two outside cylinders, in the 4-4-0 locomotives of the Paris-Lyons-Mediterranean Railway only 5.6 per cent. of the reciprocating masses are balanced. This corresponds at a speed of 74.5 miles per hour to centrifugal force of about 750 pounds. On the other hand, with the 4-4-2 locomotives of the same railway, which were built in America, 29 per cent. of these masses are balanced. This corresponds at a speed of 74.5 miles per hour to a centrifugal force of about 2,866 pounds, equal to 15 or 16 per cent. of the static wheel load.

With locomotives having two inside cylinders the balancing of the reciprocating masses varies between 25 per cent., which on the 4-4-0 locomotive of the Baden State Railway corresponds to an additional wheel load of 8.3 per cent., due to centrifugal force; and 67 to 70 per cent., on the Great Eastern Railway, Great Western Railway, and Lancashire and Yorkshire Railway. The reciprocating masses are not balanced at all on the four cylinder locomotives of the German and most of the French lines. They are satisfied with the balancing which results from the opposite direction in which the pistons move. Accordingly no centrifugal forces are produced in the case of these locomotives. On the other hand, the Belgian State Railway balances the whole of the reciprocating masses on its four-cylinder compound locomotives, although the pistons move in opposite directions. The 4-4-0 locomotives of the French Northern Railway have 30 per cent. of the reciprocating masses balanced, and the resulting centrifugal force does not exceed 10 per cent. of the wheel load, even at the speed of 74.5 miles per hour.

Complexity Combated by Perfect Organization.

Of the lesser items in design there is little of value to be said. Some of them are exceedingly cumbersome and costly, and in contrast with other and greater ideas which have been so admirably worked out, become almost absurdities. A brief mention of the methods for lubrication, which detail is in receipt of the most constant care in foreign countries, may illustrate that the possibility of complication beyond the point of accessibility is a factor scarcely ever reckoned with. The appliance in mind enters into the construction of the 4-6-2 locomotive for the Baden State Railway, and is on the principle of central lubrication, which provides for delivering the lubricant from one center to a number of different points. To this end two oil pumps, each ten-fold, are employed. They are so arranged that the quantity of oil supplied to all points of lubrication can be varied simultaneously; and apart from this, the quantity delivered to each point can be within certain limits adjusted as required. The idea is excellent, and it works, but 93 separate fittings and nearly one mile of total length copper pipe is required to equip the device. Two ordinary sight feed lubricators would do the work equally well at about one-tenth the cost of installation, and one-twentieth that of maintenance. These latter are more used in England, but on the continent oil pumps, oil presses and other weird devices abound in profusion.

These locomotives can and do maintain a sustained speed of more than 60 miles an hour, but many elements other than design enter into the array of successful factors toward that end (1) the engine always has reserve power over the weight behind it, no matter how hard apparently it may be working (2) it is handled by the same crew every trip, who are thoroughly familiar with its construction, and who have confidence in what it can do when properly handled, (3) they are paid so much per minute for every minute of lost time regained, the amount dependent on the importance of the train, and for economy in the use of coal and oil, (4) they are fined for burning more coal than is allotted for the trip, and heavily fined for arriving late, should investigation prove the fault to be their own, (5) the engine is absolutely and adequately maintained in connection with roundhouse work, not the slightest defect being allowed to go unremedied, (6) the fuel is the very best procurable, even if it becomes necessary to import it from other countries, (7) the high speed roads are uniformly free from anything like high gradients or high degree curves.

In conclusion, attention may be fittingly called to the high average annual mileage as particularily noteworthy for engines engaged in such exacting service. This on the Baden State Railway, the Orleans Railway and the Caledonian Railway reaches 62,000 miles. Finally some particulars of the maximum annual mileage of individual locomotives are of interest. Such figures are given by the Baden State Railway, 108,134 miles, and by the French Northern Railway, 69,900 miles, the locomotives in both cases being of the 4-6-2 type.

A CASCADE SUPERHEATER

The high cost of fuel on the continent of Europe and the necessity for securing increased locomotive efficiency within somewhat narrow limitations in design, has resulted in much more extensive superheating experiments than has been the case in this country. It may in fact be said that several devices to secure this end, notably the Schmidt and the Pielock superheaters, have emerged from the experimental stage to be adopted as standard on many roads abroad, but investigations still continue in many quarters on a most elaborate scale.

One of the most interesting of the new superheaters is that on the cascade system which was exhibited by the French Eastern Ry. at the Brussels Exhibition, in connection with one of its express locomotives for the fastest heavy traffic. The Eastern arrangement is devised to obtain large superheating effect with small heating surface, and in it the straight flow arrangement of U pipes is abandoned for a straight flow delivery with spiral flow return.

Briefly described, the large flues of 5 in. inside diameter and 5¼ in. outside diameter contain annular superheating elements, consisting of a large tube with a closed end, reaching to within 27 in. of the firebox, and having eight external ribs along its entire length. The gases from the fire pass between these two surfaces, licking the radiating ribs. Inside the closed tube is another, to whose outside surface is welded a spiral rib, forming a partition when fitted in the jacket tube and in its return course the steam winds through the spiral channel thus formed. The saturated steam flows straight through the inner tube up to the closed end of the outer tube. A suitable steel casting union connecting with the annular and central orifices is provided at the smoke box end, and joined by short pipes to the respective headers for superheated and saturated steams.

The arrangement of the elements for the primary and secondary superheater, or reheater, as the receiver superheater is sometimes termed, is as follows, "H" indicating the high and "L" the low pressure elements:

L L L L L L L
L H H H H H L
L H H H H H L

There are thus eleven low-pressure and ten high-pressure elements, the exterior heating surface of the low pressure being 188 sq. ft., and of the high pressure 181 sq. ft. It is evident that there is in this arrangement a certain complication of large pipes that are unavoidably necessary with the divided system of cylinders, this latter being much favored at present even in the four-cylinder simple types. The question of very high temperature superheating in main line express engines has been associated with the French Eastern Line since 1850, but the want of a suitable lubricant until recently broke off the research. This trouble has now been overcome and the oil is dispersed in the steam previous to its admission in the high pressure or low pressure valves.

NEW DUPLEX ROD BORING MACHINE

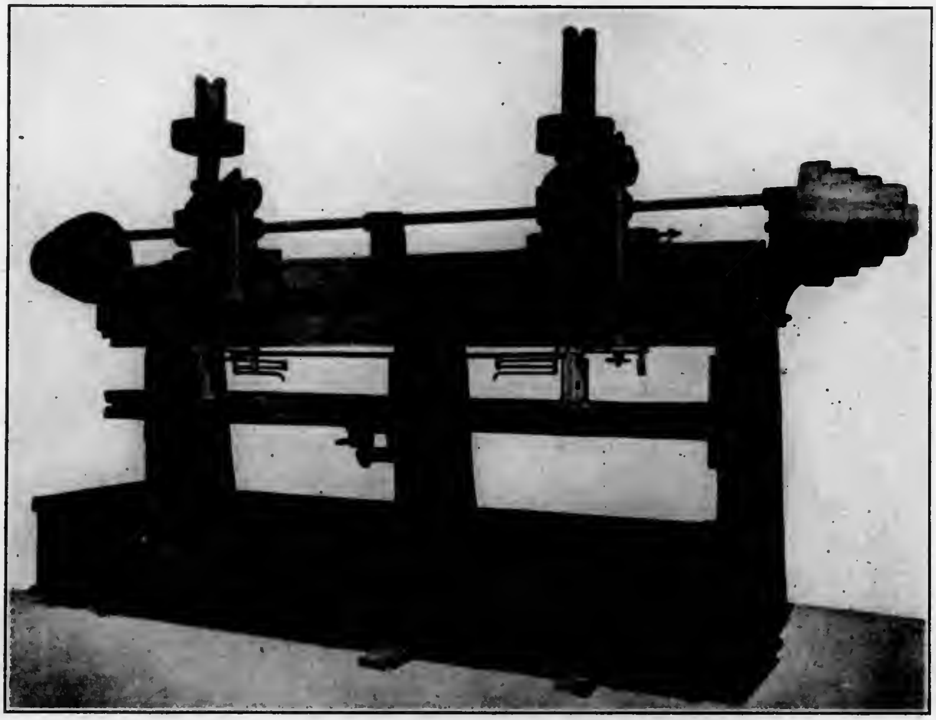
This handsome and substantial tool represents a new design of duplex rod boring machine by the Newton Machine Tool Works, of Philadelphia, Pa. It has been specially developed to obtain the maximum output from the best of high speed steel, and to increase the rigidity by properly supporting the spindles. The number of parts for which the machine can now be successfully used has been much increased, and driving boxes can be readily included in the range of work. The massive proportions of the base and the three uprights combined with the box type construction of the rail, which is of very heavy section braced internally by a great number of heavy ribs, secures primary factors of unusual strength so essential in tools of this character. This also applies to the spindle saddle which is of very interesting construction and will repay a careful study.

It will be noted that the saddle has an angular bearing on the bottom surface of the rail, insuring a closer contact with heavier pressures, and the top bearing is square, the adjustment being made by means of a bronze taper shoe on the top, and in the rear by a gib bolted to the saddle. The adjusting nut and pinion, respectively to hold the saddle in any predetermined position on the rail, and to permit of adjusting it crosswise, are plainly shown in the illustration. The solid end of the pinion is squared, and has a removable ratchet fitted for the cross adjustment.

The spindles are each 4¼ in. in diameter and revolve in bushed bearings in the sleeve, which has a bearing of 28½ in. over all. The outer diameter of the sleeve is 5¾ in. The length of the spindle feed and hand vertical adjustment is 16 in. The spindle is fitted with a No. 6 Morse taper, threaded externally, and fitted with circular nuts which engage the key fitted through the spindle and cutters to facilitate removing the cutter or to draw it tightly in place. The spindles are driven by worm and worm wheel, the latter having a bronze ring in which the teeth are cut; the driving worm being of hardened steel with roller thrust bearings, and both being encased for continual lubrication. The extension of the spindle fitting in the rack sleeve revolves in brass bushings and presses against a fibre washer, which takes the thrust. The upper end of this spindle and rack sleeve are encased and protected from dust and dirt by the cover, which serves as a support for the counterweight.

A very important feature in this design is that the thrust of the driving worm is taken by bearings cast solid with the saddle. For ordinary requirements the drive is through spur gears from the four-step cone, and where desired for motor or belt connection, back gears are placed on the drive, giving a spindle rotation with a range of 10 to 1. This permits of drilling stud pin holes and finishing both externally and internally the projections for oil cups, a very valuable feature in repair shops not having enough of the boring to keep the machine busy on the same operations.

Motion for the feed is taken through spiral gears, one of which is mounted on the spindle sleeve and the other is keyed to the horizontal pull pin shaft, on which are also mounted four pull pin gears giving four changes of feed, transmitted to the rack sleeve through the worm and worm wheel. This motion is clutched by means of a cone friction, which permits of either power feed or hand elevation. The saddles can be adjusted on the rail from a minimum distance between centers of spindles of 30 in., and a maximum of 11 ft. 4 in. The distance from the bottom of the spindle to the work table with spindle in its highest position is 25½ in. The feeds per revolution of spindle provided are .0023 in., .0042 in., .0070 in. and .0118 in. The auxiliary support for the spindles has a bearing on each upright and hand elevation through worm and worm wheel. The particular use for this bearing is to securely support the spindle at the lowest possible point when cutting, permitting the use of modern cup cutters by which a cut carrying from ½ in. to ¾ in. only is made when boring the rods, thus eliminating the necessity of drilling a pilot hole and saving the center, which can later be used as a body for inserted tooth cutters or for gear blanks, etc.



THE NEW DESIGN NEWTON DUPLEX ROD BORING MACHINE.

Several of these machines are in practice and are daily boring both ends of a rod at the same time, a number of which have been 10 in. in diameter, the rod 5 in. thick, and the time of cutting was twenty minutes. Only one cut is taken, the next operation being a reaming cut which completes the boring operation. When motor driven, a 10 h.p. motor at 220 volts, having a speed range of from 400 to 1,200 r.p.m. is generally used. The floor space required is 14 ft. 2 in. by 5 ft. 5 in., and the approximate net weight of the machine is 28,500 lbs.

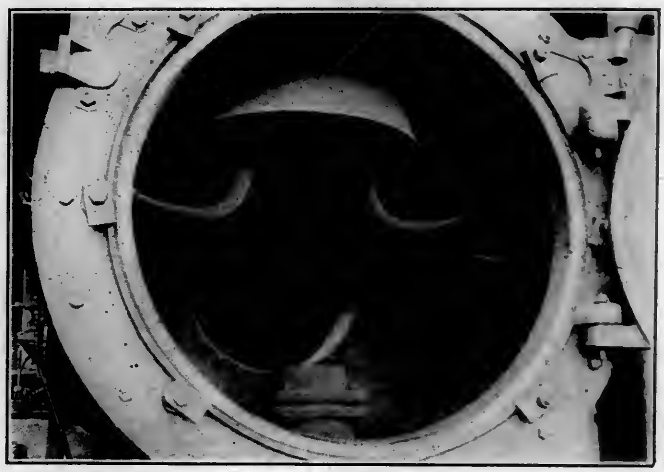
LARGE LUMBER ORDER.—The Chicago, Burlington and Quincy Railroad has placed an order for 20,000,000 feet of lumber, most of which will be manufactured on the Pacific Northwest.

VAN HORN-ENDSLEY SPARK ARRESTER

Although the crying need therefor is generally recognized, it nevertheless remains a curious fact that the development of some practical form of spark arrester has not proceeded with the rapidity so characteristic of other and possibly less important details. The majority of the many patented contrivances of the past were in a large sense failures, or at all events they lived their day without accomplishing much more toward the end desired than can be done through the proper arrangement of existing draft appliances. Hence, through the field still remaining unoccupied, particular interest still attaches to any new device destined to eliminate the objectionable feature of spark throwing which has hitherto been practically inseparable from locomotive operation.

The Van Horn-Endsley spark arrester, of which an outline drawing and photograph are shown, is the final result of numerous tests using the centrifugal principle. It will be noted that the general arrangement of the design embodies many peculiarities, in particular the very long front end, which is well illustrated in the outline drawing, and represents this spark arrester as applied for test to an engine of the Chicago & Northwestern Ry. The front end consists of what might be called three chambers, marked (A), (B) and (C). Chamber A takes up 38 in. of the front end, and in its center is located the stack, the dimensions of which are indicated. The exhaust nozzle is located directly under the stack, and the exhaust steam is carried thereto from under the saddle by the two passages shown. In other words the nozzle and stack were in this instance moved 61 in. forward of their ordinary position.

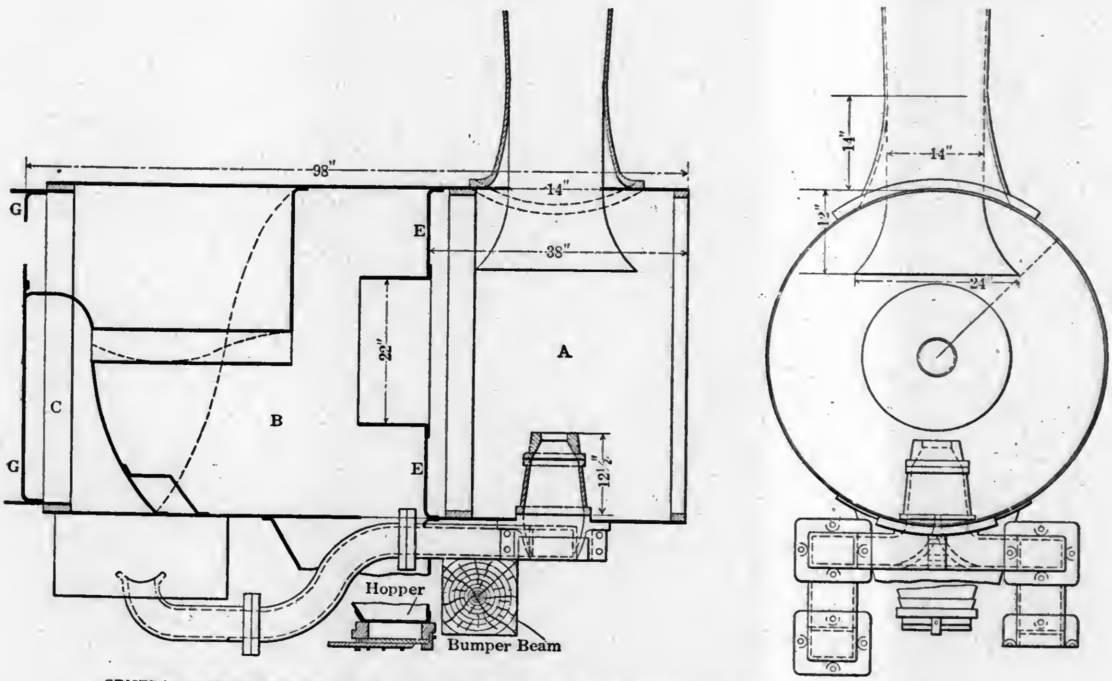
Separating chamber A from chamber B is a large circular plate E E, in the center of which is an opening 22 inches in diameter, and projecting out from this opening into chamber B is a collar 10 in. long having the same diameter as the opening vances during one revolution a distance of 30 inches. The inside edge of the spiral diaphragm follows the outside wall of a 5-in. tube in the center of the smoke-box and advances the same amount as the outside edge. In the lowest part of the spiral is located an opening 6 x 6 in. This opening, which is known



INTERIOR OF SMOKE BOX.

as a vent, can be seen in the side view of the drawing. In most cases of remodeling a 24-in. extension would be required to the existing front end, and a gooseneck form for the exhaust nozzle.

The claim made for this form of front end, which is handled by the American Spark Arrester Co., Indianapolis, Ind., is that



GENERAL ARRANGEMENT OF EXTENDED SMOKE BOX FOR VAN HORN-ENDSLEY SPARK ARRESTER.

in plate E E. This opening is the only connection between chamber A and chamber B. At the bottom of chamber B is located a hopper which projects 24 in. down from the smoke-box and has a slide in the bottom for opening and cleaning out. At the back of chamber B is located a spiral diaphragm of one revolution which diaphragm separates chamber B from chamber C, chamber C being that part of the smoke-box just in front of the tube sheet G G. This diaphragm consists of a spiral plate, the periphery of which follows the inside wall of the smoke box and ad-

the gases coming through the tube sheet are diverted by means of the spiral diaphragm from chamber C into chamber B where they are given a rotary motion around the wall of the smoke-box. This motion throws all heavy particles such as cinders to the outside wall and carries them forward over the hopper in which they are deposited. The rarified gases pass through the opening in the collar to chamber A and thence to stack.

The Chicago & Northwestern locomotive equipped with this device has been given a series of tests on the Purdue University

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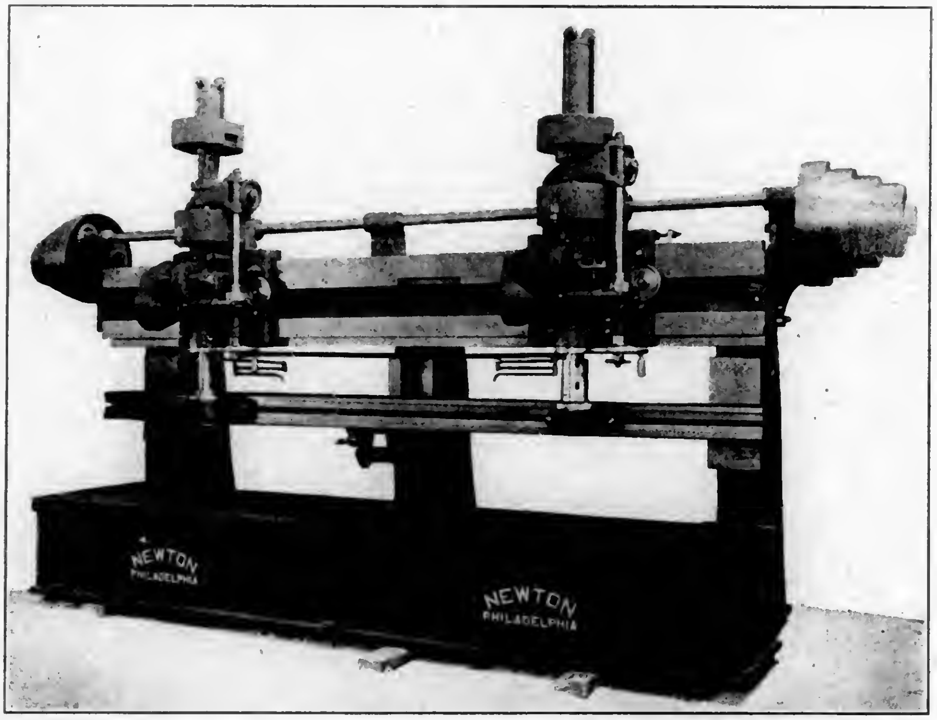


THE NEW DESIGN NEWTON DUPLEX ROD BORING MACHINE.

The spindles are each 4¼ in. in diameter and revolve in bushed bearings in the sleeve, which has a bearing of 28½ in. over all. The outer diameter of the sleeve is 5¾ in. The length of the spindle feed and hand vertical adjustment is 16 in. The spindle is fitted with a No. 6 Morse taper, threaded externally, and fitted with circular nuts which engage the key fitted through the spindle and cutters to facilitate removing the cutter or to draw it tightly in place. The spindles are driven by worm and worm wheel, the latter having a bronze ring in which the teeth are cut; the driving worm being of hardened steel with roller thrust bearings, and both being encased for continual lubrication. The extension of the spindle fitting in the rack sleeve revolves in brass bushings and presses against a fibre washer, which takes the thrust. The upper end of this spindle and rack sleeve are encased and protected from dust and dirt by the cover, which serves as a support for the counterweight.

A very important feature in this design is that the thrust of the driving worm is taken by bearings cast solid with the saddle. For ordinary requirements the drive is through spur gears from the four-step cone, and where desired for motor or belt connection, back gears are placed on the drive, giving a spindle rotation with a range of 10 to 1. This permits of drilling stud pin holes and finishing both externally and internally the projections for oil cups, a very valuable feature in repair shops not having enough of the boring to keep the machine busy on the same operations.

Motion for the feed is taken through spiral gears, one of which is mounted on the spindle sleeve and the other is keyed to the horizontal pull pin shaft, on which are also mounted four pull pin gears giving four changes of feed, transmitted to the rack sleeve through the worm and worm wheel. This motion is clutched by means of a cone friction, which permits of either power feed or hand elevation. The saddles can be adjusted on the rail from a minimum distance between centers of spindles of 30 in., and a maximum of 11 ft. 4 in. The distance from the bottom of the spindle to the work table with spindle in its highest position is 25½ in. The feeds per revolution of spindle provided are .0023 in., .0042 in., .0070 in. and .0118 in. The auxiliary support for the spindles has a bearing on each upright and hand elevation through worm and worm wheel. The particular use for this bearing is to securely support the spindle at the lowest possible point when cutting, permitting the use of modern cup cutters by which a cut carrying from ½ in. to ¾ in. only is made when boring the rods, thus eliminating the necessity of drilling a pilot hole and saving the center, which can later be used as a body for inserted tooth cutters or for gear blanks, etc.

Several of these machines are in practice and are daily boring both ends of a rod at the same time, a number of which have been 10 in. in diameter, the rod 5 in. thick, and the time of cutting was twenty minutes. Only one cut is taken, the next operation being a reaming cut which completes the boring operation. When motor driven, a 10 h.p. motor at 220 volts, having a speed range of from 400 to 1,200 r.p.m. is generally used. The floor space required is 14 ft. 2 in. by 5 ft. 5 in., and the approximate net weight of the machine is 28,500 lbs.

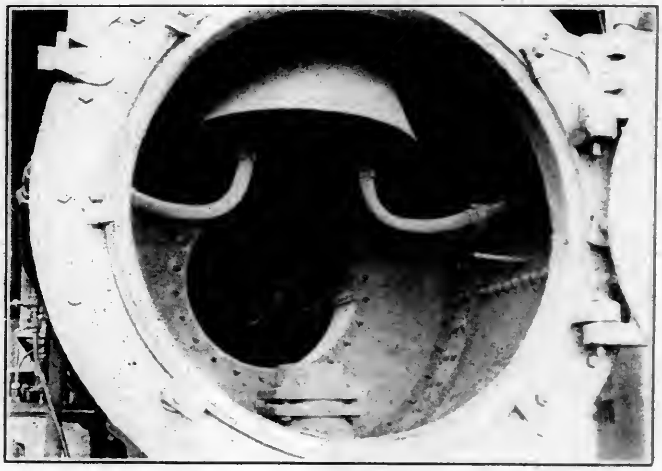
LARGE LUMBER ORDER.—The Chicago, Burlington and Quincy Railroad has placed an order for 20,000,000 feet of lumber, most of which will be manufactured on the Pacific Northwest.

VAN HORN-ENDSLEY SPARK ARRESTER

Although the crying need therefor is generally recognized, it nevertheless remains a curious fact that the development of some practical form of spark arrester has not proceeded with the rapidity so characteristic of other and possibly less important details. The majority of the many patented contrivances of the past were in a large sense failures, or at all events they lived their day without accomplishing much more toward the end desired than can be done through the proper arrangement of existing draft appliances. Hence, through the field still remaining unoccupied, particular interest still attaches to any new device destined to eliminate the objectionable feature of spark throwing which has hitherto been practically inseparable from locomotive operation.

The Van Horn-Endsley spark arrester, of which an outline drawing and photograph are shown, is the final result of numerous tests using the centrifugal principle. It will be noted that the general arrangement of the design embodies many peculiarities, in particular the very long front end, which is well illustrated in the outline drawing, and represents this spark arrester as applied for test to an engine of the Chicago & Northwestern Ry. The front end consists of what might be called three chambers, marked (A), (B) and (C). Chamber A takes up 38 in. of the front end, and in its center is located the stack, the dimensions of which are indicated. The exhaust nozzle is located directly under the stack, and the exhaust steam is carried thereto from under the saddle by the two passages shown. In other words the nozzle and stack were in this instance moved 61 in. forward of their ordinary position.

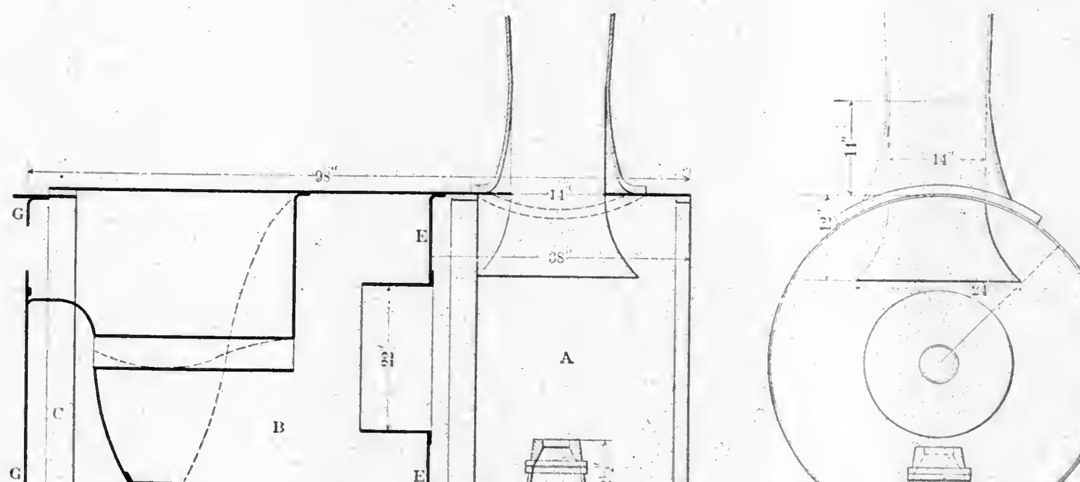
Separating chamber A from chamber B is a large circular plate E E, in the center of which is an opening 22 inches in diameter, and projecting out from this opening into chamber B is a collar 10 in. long having the same diameter as the opening vances during one revolution a distance of 30 inches. The inside edge of the spiral diaphragm follows the outside wall of a 5-in. tube in the center of the smoke-box and advances the same amount as the outside edge. In the lowest part of the spiral is located an opening 6 x 6 in. This opening, which is known



INTERIOR OF SMOKE BOX.

as a vent, can be seen in the side view of the drawing. In most cases of remodeling a 24-in. extension would be required to the existing front end, and a gooseneck form for the exhaust nozzle.

The claim made for this form of front end, which is handled by the American Spark Arrester Co., Indianapolis, Ind., is that



GENERAL ARRANGEMENT OF EXTENDED SMOKE BOX FOR VAN HORN-ENDSLEY SPARK ARRESTER.

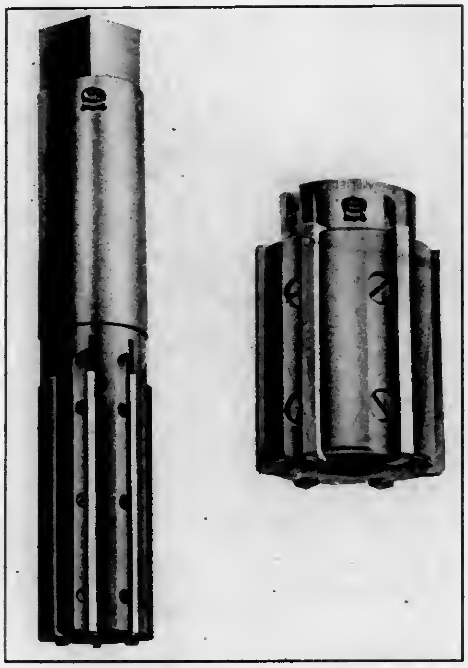
in plate E E. This opening is the only connection between chamber A and chamber B. At the bottom of chamber B is located a hopper which projects 24 in. down from the smoke-box and has a slide in the bottom for opening and cleaning out. At the back of chamber B is located a spiral diaphragm of one revolution which diaphragm separates chamber B from chamber C, chamber C being that part of the smoke-box just in front of the tube sheet G G. This diaphragm consists of a spiral plate, the periphery of which follows the inside wall of the smoke box and ad- the gases coming through the tube sheet are diverted by means of the spiral diaphragm from chamber C into chamber B where they are given a rotary motion around the wall of the smoke-box. This motion throws all heavy particles such as cinders to the outside wall and carries them forward over the hopper in which they are deposited. The rarified gases pass through the opening in the collar to chamber A and thence to stack.

The Chicago & Northwestern locomotive equipped with this device has been given a series of tests on the Purdue University

testing plant in which much interesting data was gathered in connection with the very small amount of sparks thrown from the stack and in the demonstration that the free steaming qualities of the engine were retained with the new front end.

A NEW ADJUSTABLE REAMER

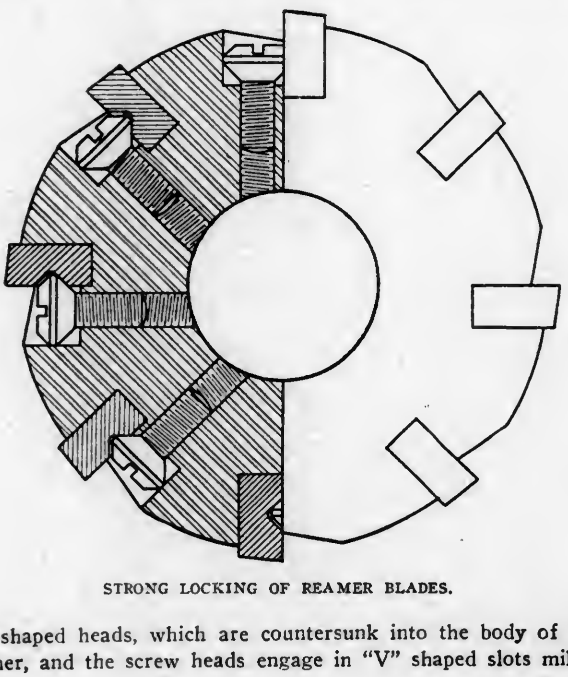
The growing demand for an adjustable reamer to be simple in construction, readily adjustable to compensate for wear, and yet solid in the sense that it will stand the most severe service, has been met in the new "StanaR" reamer by the Standard Tool



THE "STANAR" REAMER.

Company, of Cleveland, O. The construction is of particular interest, as it not only seats and holds the blades rigidly against the bottom and back of the slot in the body, thus preventing any tendency to spring, but prevents absolutely any endwise motion.

This is secured by means of heavy screws provided with spe-



STRONG LOCKING OF REAMER BLADES.

cial shaped heads, which are countersunk into the body of the reamer, and the screw heads engage in "V" shaped slots milled in the face of each blade. It will be noted that the blades are unevenly spaced, which prevents chatter and insures a smooth hole. They can be ground with end clearance for machine reaming or chucking work, as they extend a sufficient distance beyond the body to permit of this being done.

After the blades are worn or when it is desired to increase the diameter, the blades can be taken out by removing the screws, and the diameter increased by placing a liner of some suitable material, preferably tin foil, and of the desired thickness, evenly in the slots under the blades, after which the blades are reground ready for use. When completely used up there is nothing to throw away but the worn out blades. The substitution of a new set makes to all intents and purposes a new reamer.

THREE-WIRE GENERATORS

The chief objection heretofore to three wire machines has been the poor commutation on unbalanced loads. This the Triumph Electric Co., of Cincinnati, O., claims to have entirely eliminated

in a generator which is absolutely sparkless on unbalanced as well as balanced loads. These generators are built as belted units, or for connection with any standard engine with which they form an exceedingly compact arrangement.

The two voltage feature of three-wire distribution is particularly advantageous for buildings or shops where variable speed motors are in use. With field control a wide range of speed can be obtained on account of the flexibility of the system, and

at the same time the saving in copper is quite a considerable item.

The accompanying illustrations show the general design and appearance of these generators. They are built in all standard sizes from 25 kw. up, and are wound for 250 volts, so that 125 volts can be obtained from either side of the three-wire system. Standard machines are designed to take care of an unbalanced load of 25 per cent., but other capacities can be obtained when desired.

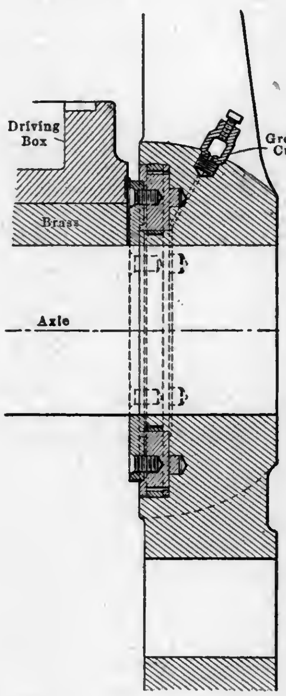
ADJUSTABLE HUB LINER FOR FOLLOWING UP LATERAL WEAR IN DRIVING WHEELS

Excessive lateral motion, particularly in locomotive drivers, is generally recognized as a prominent detrimental feature and much experimenting has been in order with the end in view to keep it within at least reasonable bounds. Unfortunately, however, none of the various common arrangements such as cast iron hub plates against brass side liners on driving boxes, or babbit lined boxes against unprotected hubs, have proved entirely satisfactory. The brass driving box liner is no doubt superior to special hard babbit for this purpose, but the accumulation of end play is inevitable, and when in serious proportions renders the proper maintenance of rod bushings, knuckle pins, etc., a matter of impossibility without frequent renewals.

In the patented hub plate which is herein illustrated the somewhat novel idea has been worked out to "follow up" the lateral motion as it grows. To this end F. H. Smith, of Pittsburg, Kansas, inventor of the device, employs an adjustable plate, which can be maintained at any required distance from the face of the driving box by the use of heavy grease behind it, pressure being secured by a screw on the outside of the driving wheel. The quality of grease, commonly known as "pin grease," is used. Its confinement by snap rings both in the plate and in the hub prevents any possiility of escape, and insures the plate remaining in proper position under any condition. The illustrations are those of the sectional plate which can be applied to a locomotive without the necessity of pressing off the driving wheel. The inside of the packing rings are lined with asbestos packing against which the grease pressure is brought.

The plate is now in operation on the Kansas City Southern Ry., where it has been adopted for all passenger and the heavier freight locomotives. Between Pittsburg and Mena on this road there are a great many curves, and the conditions under which the adjustable hub plates have been working satisfactorily are particularly severe.

COMPONENT PARTS OF THE NEW ADJUSTABLE HUB PLATE.



SECTIONAL VIEW OF SMITH HUB PLATE.

THE PENNSYLVANIA RAILROAD TO BRIDGE EAST RIVER.—Notwithstanding its new tunnels under both the Hudson and East Rivers, the Pennsylvania Railroad has under consideration the construction of an East River bridge. This was made known in a letter from Vice-president Samuel Rea, as read before the Municipal Art Society, of New York. "I hope that before very long," he writes, "our company will be actively engaged in the construction of the bridge across the East River, and we will take all steps in our power to make this bridge not inly impressive because of its proportions, but beautiful in its design, and a monumental feature of the City of New York."

IN GREAT BRITAIN THE TAX ON MOTOR CARS is of great encouragement to the moderate sized car. Autos of less than 6½ horsepower are only taxed $10.22 per year. From this size the scale is a gradually increasing one. A car from 40 to 60 horsepower is taxed $102.39. Cars over 60 horsepower have to pay the tidy sum of $204.39 for the privilege of developing high speeds on the public highway.

ON CERTAIN LINES IN BOTH AUSTRIA AND HUNGARY a passenger, on the payment of a fixed charge for a certificate known as "Legitimation" may thereafter purchase tickets at half the ordinary fares. This Legitimation charge for first class is $64; for second class, $38; for third class, $24.

THE LARGEST STEAMSHIP.—The Cunard Steamship Company is stated to have approved plans for a steamship which will eclipse the *Olympic* of the White Star Line. The new vessel will be 1,000 ft. in length. She will have 90,000 horsepower, which will give her a speed of 25 knots an hour.

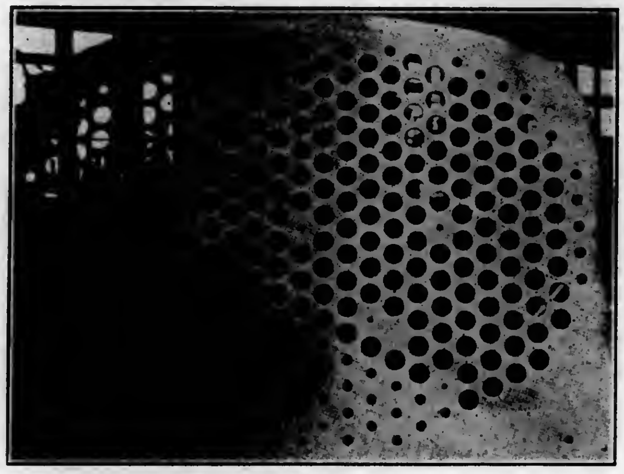
A NEW SYSTEM OF AUTOMATIC SIGNALS is to be installed at once on the Warren, Bristol and Fall River division of the New York, New Haven & Hartford Railroad.

A NEW PLAN FOR FLUE SPACING

CHICAGO & NORTHWESTERN RY.

In an interesting paper on "Flue Failures," read before the Western Railway Club, the author, J. W. Kelly, recommended the scheme which is herein illustrated for flue spacing and back flue sheet bracing. At first glance this would appear as a badly plugged set of flues, and this is exactly on what the idea is based, as may be gathered from the following quotation:

If it is possible to run an engine with the bottom flues plugged and she still does good work, and is light on coal, why not leave these flues out, so they will not be there to contract and leak? So with this point in view,



NEW LAYOUT FOR FLUES.

I got permission to experiment with one engine. I plugged up about forty flues and put a stay rod in center of plugs, generally termed sun-flowers. The engine went into service and did as well or a little better as to coal, and steamed fine. The flues were applied November 6, 1907, and the engine was put in heavy freight service for test purposes. Flues gave very little trouble, and were removed when engine received general repairs to machinery, but they were still in fair condition on April 7, 1910. The point I want to make is this: Do not crowd in too many flues because you must have the required heating surface. Keep the top flues down, say, from 4 in. to 4½ in. from the flange to center of flue hole, and all flue holes not less than 3 in. from flange.

The illustration represents the standard layout, following Mr. Kelly's suggestion, for all new back flue sheets applied on the Chicago & Northwestern Ry., with stay rod holes in bottom center where flues are left out. These engines when received from the locomotive works has 342 flues, ⅝ in. bridge. They have with present layout, 280 flues, 13/16 in. bridge. It will be noted that the flues are laid out with the taper of sides of the flue sheet, which permits a wider bridge at the bottom, better circulation and a chance to let the sediment down. In the opinion of Mr. Kelly this plan is to be recommended wherever it can be applied, and he believes that it will be necessary to go further than this in reinforcing the back flue sheet in some manner to help take care of the sudden contraction of flues and the upward movement of the back flue sheet and flues.

In regard to this latter feature the author of the paper makes the following interesting remarks:

An Atlantic type engine came into the shop for new fire box, and when removed, I found the flue sheet had moved upwards in the center about 1⅜ in., making the crown sheet look as if it was dropping down, but when a straight edge was placed on it, we found that the crown sheet had started to raise up about 18 in. from back flue sheet. So I put a straight edge on the new fire box and found it straight, then I took a tram and trammed it in center of flange on top and lower point between staybolts. Then the flues were set by expanding with sectional expanders and rolled very light, then beaded with a standard beading tool and inspected before the flue setter left the job, to insure proper work. I then trammed sheet and found it had moved upwards 3/16 in. This surprised the flue setter very much. I sent the tram with the engine for test and had the men report the movement of sheet every time the flues were expanded. It was as follows:

On Feb. 4, 1910, flues expanded and trammed after work was completed, and found movement of 1/16 in., or total movement of ¼ in. upward.
March 11, 1910, expanded light, still ¼ in.
April 15, 1910, expanded light, still ¼ in.
May 29, 1910, expanded light, moved 1/32 in., total 9/32 in.
July 10, 1910, expanded light, moved 1/32 in., total 5/16 in.
July 20, 1910, expanded light, full set moved 3/64 in., total 23/64 in.
August 18, 1910, expanded light, full set moved 1/32 in., total 25/64 in.
Sept. 20, 1910, expanded light, full set moved 3/64 in., total 7/16 in.
Oct. 8, 1910, expanded light, no movement, total 7/16 in.

The general tenor of the paper is rather critical, both in regard to existing schemes of flue spacing and of the care, or rather the alleged lack of it, given boilers at terminals, but it is practically worded and is a valuable contribution to the literature on the subject.

ELECTRICALLY DRIVEN SWING SAW

A striking example of what can be accomplished in securing compactness and portability in connection with a tool where it is generally lacking, is exhibited in the arrangement of the Reliance swing saw herein illustrated, which is a product of the Reno-Kaetker Electric Co., of Cincinnati, O. The extreme simplicity as well as the unusual strength of the frame is quite apparent, and as the outfit is entirely self-contained it can be mounted either upon the ceiling, side wall, or upon a portable standard located in some out of the way place.

The machine is adapted for any standard make motor, and as the latter is mounted directly on the base of the saw frame the construction does away with needless countershafting and belting. This insures that no power is wasted by running idle and

eliminates all useless weight and belt friction. The base supporting the motor is of heavily ribbed cast iron and the saw frame is a heavy cast iron cylinder. The saw, which is counterbalanced so that it automatically returns as soon as the handle is released, is forced to follow its cut. The operator, without changing his position, can start and stop at will, the starting box and switch being placed in a most convenient location.

THE RIVER TUNNELS leading to the Pennsylvania station in New York are, all told, 6.8 miles long, and the land tunnels have the same length. From the Bergen Hill portal in New Jersey to the Long Island entrance of the tunnels is 5.3 miles. It is 8.6 miles from Harrison, New Jersey, to the station in New York, while from the latter point to Jamaica the distance is 11.85 miles.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 3	Efficiency of Tools and Economy in Their Manufacture	Wm. Townsend	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	Jan. 12	Annual Meeting and Banquet—Paper on Lubrication of Locomotive Valves	W. O. Taylor	H. D. Vought	95 Liberty St, New York
New England	Jan. 10	Safe Transportation of Explosives	Col. W. B. Dunn	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	Jan. 20	....	....	H. D. Vought	95 Liberty St., New York
Northern	Jan. 28	....	....	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Jan. 27	....	....	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Jan. 13	Ladies' Night	....	F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	Jan. 19	....	....	A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Jan. 13	Valve gears	R. S. Darby	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Jan. 16	Cast iron wheels..........	....	J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	Jan. 9	....	....	W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

THE TRAINING OF THE RAILROAD EMPLOYEE

WESTERN CANADA RAILWAY CLUB.

At the November meeting of this club, H. Martin Gower, superintendent of apprentices of the Canadian Pacific Railway, presented a most interesting and instructive paper upon the work in which he is directly engaged. The subject was viewed from a very broad standpoint and the paper is too comprehensive to be given a proper mention in this place. It will be presented in abstract in a later issue of this journal.

ANNUAL MEETING

RICHMOND RAILWAY CLUB.

At the annual meeting held on November 14 the report of the secretary showed that the club had a membership of 328 and a balance on hand of $1,117.76. A change in the meeting night was made from the second Monday to the second Friday in each month. The following officers were declared elected for the ensuing year: President, H. M. Boykin; first vice-president, E. H. Lea; second vice-president, A. H. Moncure; third vice-president, B. T. Jellison; treasurer, F. O. Robinson. Executive Committee: G. W. Stevens, J. F. Walsh and W. H. White. Finance Committee: Charles Lorraine, C. C. Corkran and J. J. Gould.

THE MODERN RAILWAY

CANADIAN RAILWAY CLUB.

At the December meeting of this club Edwin F. Wendt, assistant engineer of the Pittsburgh & Lake Erie Railroad, presented a paper, generally historical in character, tracing briefly the history of transportation from the time of Noah and the Ark to the present date. Many facts of decided historical interest are incorporated in this paper, especially in connection with the work of George Stevenson. The railway executives of the present day were discussed personally, especial attention being drawn to the fact that the most prominent of the present day successful railroad men rose from the lowest rank by their own efforts. The present day organization of railroads was also discussed and government supervision was considered briefly.

LOCOMOTIVE FUEL ECONOMY

RAILWAY CLUB OF PITTSBURG.

A most interesting and important paper was presented by A. G. Kinyin, fuel expert of the Buffalo, Rochester & Pittsburgh Railway, at the October meeting of this club. The paper again drew attention to the opportunity for very large saving which can be obtained by proper attention to fuel economy. It spoke most highly of the work of the International Railway Fuel Association along these lines. The author considered the various phases of the subject separately, first discussing the supply of coal and the proper method of handling and storing and the value of performance sheets, following which was a lengthy talk on condition of locomotives, pointing out wherein many things, apparently small in themselves, were really expensive on fuel. The best method of kindling fires, taking care of fires at terminals, etc., were not overlooked and the paper concluded with a discussion of the best method of instructing firemen, hostlers, and others in fuel economy. The paper was given an extensive discussion, indicating the great interest that is everywhere being shown in this most important subject.

The secretary's report showed that the club now has a membership of 752 and a balance on hand of $1,769.26.

The election of officers resulted as follows: F. R. McFeatters, president; William Elmer, first vice-president; A. G. Mitchell, second vice-president; J. M. McIlwain, treasurer; C. W. Alleman, secretary. Executive Committee: L. H. Turner, F. H. Stark, D. J. Redding. Finance Committee: D. C. Noble, Stephen C. Mason, C. E. Postlethwaite. Membership Committee: D. M. Howe, C. A. Lindstrom, A. L. Humphrey, M. A. Malloy and G. P. Sweeley.

PASSENGER CAR HEATING

NEW ENGLAND RAILROAD CLUB.

George E. Hulse, chief engineer of the Safety Car Heating and Lighting Company, presented at the November meeting of the above club a very interesting paper on the subject of heating passenger cars, discussing in detail the various systems that have been tried and are already in use, pointing out the advantages and disadvantages of each. A large part of the paper was confined to an explanation and thorough description of the system used by the Safety Car Heating and Lighting Co., this being very thoroughly illustrated by sectional views and photographs of the various parts of the apparatus. Results of tests were given.

W. F. Ray, superintendent of the Concord Division of the Boston and Maine Railroad, opened the discussion and gave some interesting anecdotes on his experience with the original steam heated train which ran on the Connecticut River Railroad between Springfield and South Vernon, Mass. The paper was also discussed by B. F. Hudson, who spoke very highly of the vapor system of car heating and gave the result of a series of eight tests which had been made on the Boston & Maine Railroad. John E. Ward, president of the Ward Equipment Co., spoke at some length on the subject, drawing attention to the introduction of steel passenger equipment which required much more heat than wooden cars. He stated that he understood this increase to be, in the case of the Pennsylvania Railroad, about 20 per cent. A number of the other members asked questions which were satisfactorily answered by Mr. Hulse.

PERSONALS

E. Nolan succeeds J. W. McCarthy as road foreman of engines of the Chicago, Peoria & St. Louis Ry.

William Bennett has been made roundhouse foreman of the Chicago Great Western Ry. at Oelwein, Ia.

W. P. Bray, has been made traveling engineer of the Missouri Pacific Ry., with office at Wichita, Kan.

H. A. Southworth succeeds A. R. Manderson as master mechanic of the Maine Central at Portland, Me.

E. F. Miller has been appointed roundhouse foreman of the Kansas City Southern Ry. at De Queen, Ark.

J. E. Davis succeeds M. A. Kinney as master mechanic of the Hocking Valley Ry., with office at Columbus, O.

Frank J. Smith, master mechanic at Washington, Ind., on the Baltimore and Ohio Southwestern Ry., has resigned.

Leo Meehan has been appointed master mechanic of the Ashland Coal and Iron Ry., with office at Ashland, Ky.

B. M. Angwin has been appointed master car builder of the Birmingham Southern Ry., vice J. N. Collins, deceased.

C. R. Dobson has been made general car foreman of the Chicago, Rock Island and Pacific Ry at Cedar Rapids, Ia.

E. J. Snell has been made master mechanic of the Pennsylvania division of the New York Central & Hudson River R. R., at Corning, N. Y.

J. L. Butler, master mechanic on the White River division of the Iron Mountain Ry., at Cotter, Ark., has been transferred to Crane, Mo.

J. F. Schwaiger has beeen appointed road foreman of engines on the Eastern district of the Wyoming division of the Union Pacific R. R.

D. D. Robertson has been appointed master mechanic of the Buffalo division of the Lehigh Valley R. R., succeeding Mr. W. Kells, resigned.

Ernest Becker has been appointed master mechanic of the Chicago and North Western Ry. at Green Bay, Wis., succeeding F. W. Peterson, transferred.

H. F. Lowther has been appointed assistant purchasing agent of the Delaware, Lackawanna & Western Ry., with office at 90 West street, New York.

A. Anderson, formerly master boilermaker of the National Railways of Mexico, has been made traveling boiler inspector, with office at San Luis Potosi, Mexico.

F. T. Slayton has been appointed superintendent of motive power of the Virginian Railway, with office at Princeton, W. Va., succeeding L. B. Rhodes, resigned.

A. E. Calkins has been made assistant to F. W. Brazier, superintendent of rolling stock of the New York Central & Hudson River R. R., with office in New York City.

George H. Bussing has been made superintendent of motive power of the New Orleans Great Northern Ry., with office at Bogalusa, La., vice H. W. Burkheimer, resigned.

J. Benzies has been appointed smoke inspector of the Terminal and Illinois divisions of the Chicago, Rock Island and Pacific Ry., with headquarters at Chicago, Ill.

T. H. Malican has been appointed master mechanic of the Mahoney and Hazleton division of the Lehigh Valley R. R., at Weatherly, Pa., succeeding W. G. Burrows, transferred.

F. W. Peterson, master mechanic of the Chicago & North Western, at Green Bay, Wis., has been appointed master mechanic of the Wisconsin division, with office at Chicago.

A. R. Manderson, master mechanic of the Maine Central R. R., has been promoted to succeed H. P. Manchester as assistant superintendent of motive power, with office at Portland, Me.

W. G. Burrows, master mechanic of the Mahoney and Hazleton division, at Weatherly, Pa., has been transferred to Wilkesbarre, Pa., succeeding D. D. Robertson, transferred to Buffalo, Lehigh Valley R. R.

George H. Eck has beeen appointed master mechanic of the Hudson River division of the New York Central & Hudson River R. R., with office at New Durham, N. J., succeeding C. E. Keenan, resigned.

Henry C. Manchester, assistant superintendent of motive power of the Maine Central R. R., has been appointed to the office of superintendent of transportation of that road. His office will be at Portland, Me.

J. T. McGrath, heretofore master mechanic in charge of the Battle Creek shops of the Grand Trunk Ry., has been appointed superintendent of rolling stock on the Chicago and Alton R. R., succeeding Peter Maher, resigned.

F. H. Clark, general superintendent of motive power of the Chicago, Burlington & Quincy Ry., at Chicago, has been appointed general superintendent of motive power of the Baltimore and Ohio R. R. and of the Baltimore and Ohio Southwestern R. R., with office at Baltimore, Md., succeeding J. D. Harris, resigned.

CATALOGS

Electrical Equipment.—The Westinghouse Electric & Manufacturing Company has issued its Part Catalogues Nos. 6141 and 6143. No. 6141 lists parts for the Westinghouse type 306 Interpole Railway Motor for direct current circuits. No. 6143 lists Standard Metallic Brushes for A. C. and D. C. circuits.

Spark Arresters.—The Van Horn-Endsley spark arrester is given a full description in an attractive catalog issued by the American Spark Arrester Co. of Indianapolis, Ind. The book also contains a very complete record of the tests given this device at Purdue University, and is illustrated with several graphic half tones.

Flare Lights for Construction Work.—The United States Marine Signal Co., of New York, has issued a catalog describing the Willson flare light which is especially designed for use in connection with all kinds of outdoor construction work, also in mines and tunnels. The book is complete with instructions in regard to the maintenance and handling of the light.

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PERSONALS

E. Nolan succeeds J. W. McCarthy as road foreman of engines of the Chicago, Peoria & St. Louis Ry.

William Bennett has been made roundhouse foreman of the Chicago Great Western Ry. at Oelwein, Ia.

W. P. Bray, has been made traveling engineer of the Missouri Pacific Ry., with office at Wichita, Kan.

H. A. Southworth succeeds A. R. Manderson as master mechanic of the Maine Central at Portland, Me.

E. F. Miller has been appointed roundhouse foreman of the Kansas City Southern Ry. at De Queen, Ark.

J. E. Davis succeeds M. A. Kinney as master mechanic of the Hocking Valley Ry., with office at Columbus, O.

Frank J. Smith, master mechanic at Washington, Ind., on the Baltimore and Ohio Southwestern Ry., has resigned.

Leo Meehan has been appointed master mechanic of the Ashland Coal and Iron Ry., with office at Ashland, Ky.

B. M. Angwin has been appointed master car builder of the Birmingham Southern Ry., vice J. N. Collins, deceased.

C. R. Dobson has been made general car foreman of the Chicago, Rock Island and Pacific Ry at Cedar Rapids, Ia.

E. J. Snell has been made master mechanic of the Pennsylvania division of the New York Central & Hudson River R. R., at Corning, N. Y.

J. L. Butler, master mechanic on the White River division of the Iron Mountain Ry., at Cotter, Ark., has been transferred to Crane, Mo.

J. F. Schwaiger has beeen appointed road foreman of engines on the Eastern district of the Wyoming division of the Union Pacific R. R.

D. D. Robertson has been appointed master mechanic of the Buffalo division of the Lehigh Valley R. R., succeeding Mr. W. Kells, resigned.

Ernest Becker has been appointed master mechanic of the Chicago and North Western Ry. at Green Bay, Wis., succeeding F. W. Peterson, transferred.

H. F. Lowther has been appointed assistant purchasing agent of the Delaware, Lackawanna & Western Ry., with office at 90 West street, New York.

A. Anderson, formerly master boilermaker of the National Railways of Mexico, has been made traveling boiler inspector, with office at San Luis Potosi, Mexico.

F. T. Slayton has been appointed superintendent of motive power of the Virginian Railway, with office at Princeton, W. Va., succeeding L. B. Rhodes, resigned.

A. E. Calkins has been made assistant to F. W. Brazier, superintendent of rolling stock of the New York Central & Hudson River R. R., with office in New York City.

George H. Bussing has been made superintendent of motive power of the New Orleans Great Northern Ry., with office at Bogalusa, La., vice H. W. Burkheimer, resigned.

J. Benzies has been appointed smoke inspector of the Terminal and Illinois divisions of the Chicago, Rock Island and Pacific Ry., with headquarters at Chicago, Ill.

T. H. Malican has been appointed master mechanic of the Mahoney and Hazleton division of the Lehigh Valley R. R., at Weatherly, Pa., succeeding W. G. Burrows, transferred.

F. W. Peterson, master mechanic of the Chicago & North Western, at Green Bay, Wis., has been appointed master mechanic of the Wisconsin division, with office at Chicago.

A. R. Manderson, master mechanic of the Maine Central R. R., has been promoted to succeed H. P. Manchester as assistant superintendent of motive power, with office at Portland, Me.

W. G. Burrows, master mechanic of the Mahoney and Hazleton division, at Weatherly, Pa., has been transferred to Wilkesbarre, Pa., succeeding D. D. Robertson, transferred to Buffalo, Lehigh Valley R. R.

George H. Eck has beeen appointed master mechanic of the Hudson River division of the New York Central & Hudson River R. R., with office at New Durham, N. J., succeeding C. E. Keenan, resigned.

Henry C. Manchester, assistant superintendent of motive power of the Maine Central R. R., has been appointed to the office of superintendent of transportation of that road. His office will be at Portland, Me.

J. T. McGrath, heretofore master mechanic in charge of the Battle Creek shops of the Grand Trunk Ry., has been appointed superintendent of rolling stock on the Chicago and Alton R. R., succeeding Peter Maher, resigned.

F. H. Clark, general superintendent of motive power of the Chicago, Burlington & Quincy Ry., at Chicago, has been appointed general superintendent of motive power of the Baltimore and Ohio R. R. and of the Baltimore and Ohio Southwestern R. R., with office at Baltimore, Md., succeeding J. D. Harris, resigned.

CATALOGS

Electrical Equipment.—The Westinghouse Electric & Manufacturing Company has issued its Part Catalogues Nos. 6141 and 6143. No. 6141 lists parts for the Westinghouse type 306 Interpole Railway Motor for direct current circuits. No. 6143 lists Standard Metallic Brushes for A. C. and D. C. circuits.

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FOR YOUR CARD INDEX

Some of the more important articles in this and the previous issues arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Cars, Steel Passenger AMER. ENG., 1911, p. 1 (January).

Fully illustrated description of the design developed by the American Car & Foundry Co., for composite steel passenger equipment. All framing and exterior sheathing is of steel, and the interior above the window sill is of wood and agasote. The design employs a heavy girder below the belt rail for carrying the entire weight of the car, including the center sills. The vestibule design is particularly interesting.

Locomotive, 4-8-0 Type—N. & W. Ry.

AMER. ENG., 1911, p. 6 (January).

Fully illustrated description of a very powerful locomotive built by the Baldwin Locomotive Works. The boiler design is of particular interest and has ogee side water legs, the mud ring being 7 in. in width. The article includes the results of tests which were made on a heavy grade.

Locomotive Maintenance Practices

AMER. ENG., 1911 p. 10 (January).

A discussion showing the limits of wear for various important locomotive parts that have been adopted by some of the roads. These show a decided difference of opinion, in some cases as much as 100 per cent.

Locomotive, Hign Speed. AMER. ENG., 1911, p. 27 (January).

A review of the development of high speed locomotives in the various countries throughout the world as portrayed by the reporters of the International Railway Congress.

Locomotive—Water Tube Fire Box

AMER. ENG., 1910, p. 472 (December).

Fully illustrated description of the Brotan Boiler. Is giving excellent results in foreign countries.

Locomotive—Valve Gear—Lentz Poppet Valve

AMER. ENG., 1910, p. 485 (December).

Illustrated description of a poppet valve gear for locomotives that is viewed with much favor on many foreign railroads.

Machine Tools—Vertical Milling Machine

AMER. ENG., 1910, p. 493 (December).

Illustrated description of a very powerful vertical milling machine manufactured by the Newton Machine Tool Works Co., Philadelphia.

Machine Tools—Planer AMER. ENG., 1910, p. 495 (December).

Illustrated description of a small planer adapted to a wide range of repair work. Built by Schneider & Goosmann, Cincinnati.

Machine Tools—Rod Boring Machihe

AMER. ENG., 1911, p. 32 (January).

Illustrated description of a new duplex rod boring machine manufactured by the Newton Machine Tool Works, Philadelphia.

Railway Business Assn. Dinner

AMER. ENG., 1910, p. 483 (December).

Abstracts of addresses of Chairman Knapp of the Interstate Commerce Commission; Daniel Willard, president of the B. & O., and H. B. Claflin, given at the second annual dinner of the Railway Business Association.

Shop Devices—Making Fire Hooks on a Bulldozer

AMER. ENG., 1910, p. 476 (December).

Illustrated description showing dies and operation of making two pronged fire hooks complete.

Shop Devices—Rivetor for Coupler Yokes

AMER. ENG., 1911, page 12 (January).

Illustrated description of a very efficient air operated riveter which will easily rivet up 200 couplers per day with a total labor cost of about 19 cents per coupler.

Shop Devices—Air Drill Press for Tool Room

AMER. ENG., 1911, p. 26 (January).

Illustrated description of an ingeniously constructed air drill press for tool room work.

Shops, Locomotive, Havelock, C. B. & Q. Ry.

AMER. ENG., 1911, p. 13 (January).

Fully illustrated description of the very extensive additions made to the Havelock shops of the C. B. & Q. R. R. The machine and erecting shop are in a large building, the latter being of the longitudinal type. The boiler work is performed in a separate building. System storehouse and oil distributing center have been constructed.

Test—Balanced Simple Locomotive With Superheater

AMER. ENG., 1911, p. 19 (January).

Results of the comparative test between balanced simple with superheater, a balanced compound and a 2-sylinder simple engine on the C. R. I. & P. Ry. Results are greatly in favor of the balanced simple locomotive.

Valve Gear—Locomotive AMER. ENG., 1911, p. 22 (January).

Fully illustrated description of the construction and operation of a new valve gear for locomotives built by the Pilliod Bros. Co. It is of the radial type and has no connection to the main crank pin, all motion being obtained from the two crossheads.

Smooth Rail Working on Heavy Gradients

PECULIAR REQUIREMENTS OF THIS SERVICE PRESENT MANY PROBLEMS TO THE LOCOMOTIVE DESIGNER WHICH HAVE NOT BEEN SATISFACTORILY SOLVED

Locomotive design for railways where steep gradients and sharp curves prevail has been a fascinating problem since the earliest days of railway engineering, yet literature on the subject is meagre, being practically confined to articles at rather rare intervals in technical publications or the proceedings of the various engineering societies. Almost invariably these occasional references have dealt with conditions of some particular case or districts, rather than with the solution of the problem on general principles.

In an extremely valuable paper before the Institution of Civil Engineers, F. W. Bach has effectively grouped together the principal considerations which should govern the design for smooth-rail working on heavy grades in general, and has refrained from any appeal to individual cases as illustrations. The data which he presents was deduced from the results of practical working, and not merely based upon more or less theoretical calculations. The author of the paper recommends, however, that while these data cover experiments over a large number of railways, with varied conditions of traffic, they must be used with reasonable caution, and may perhaps need modification in cases where climatic or other conditions of special character introduce unusual factors into the working.

Although somewhat outside the strict review of this paper, a brief consideration of the limit of gradient which can be operated by a steam locomotive working on smooth rails is important. The very rapid rise in the cost of haulage with grades exceeding 4 per cent. (1 in 25) leads to the opinion that for grades steeper than this, special devices, such as racks or center rails should be employed, so as to admit of heavier train weights. It will be found that although gradients of 6 per cent., or even 8 per cent., are not unknown in special cases, a gradient of 4 per cent. has been recognized very generally by engineers as the limit for economical smooth-rail working. Mr. Bach, in fact, adopted this limit as the maximum gradient to be dealt with for the purpose of his paper.

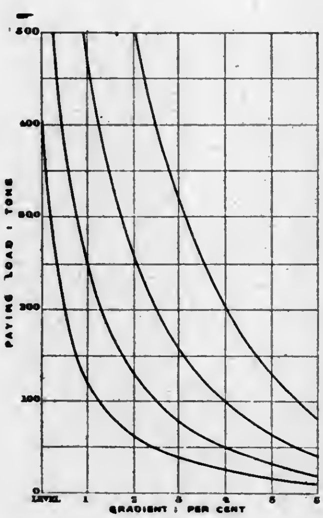


FIG. 1.

In Fig. 1 are shown approximately the relative loads which ordinary locomotives will haul, in addition to their own weight, on various gradients. It will be seen that an engine which will haul a 200-ton train on a 2½ per cent. grade, will only haul one-half this amount on a 4 per cent. one, and on a 6 per cent. gradient its load would fall to 44 tons. In plotting this diagram 25 per cent. of the total weight of engine and tender has been assigned to coal and water carried. The safe speed of descent for a given axle load on a 6 per cent. grade is only about two-thirds of that which is safe on a 4 per cent. one: the capacity of a line with the former being, therefore, hardly more than one-half that of a line with the latter; and as the cost per train mile will certainly not be less, the tariff would need to be higher in proportion.

In the consideration of locomotive design a difficulty is often encountered in determining with certainty what tractive effort a certain engine will exert in actual service. Much difference of opinion exists as to what figure it is reasonable to take for the nominal mean effective pressure in the cylinders, and further as to what is a proper allowance to make for friction in the locomotive. Many experiments to determine draw-bar pull have been made, but the conditions vary so considerably that the results are of little service for generalizations.

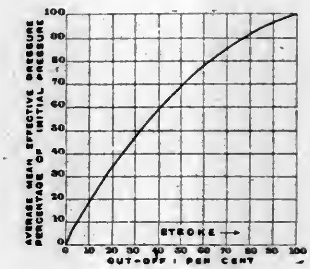


FIG. 2.

The curve shown in Fig. 2 has been obtained from analysis of a large number of indicator diagrams, and shows the mean effective pressure obtained in practice, in terms of the initial pressure in the cylinder. Fig. 3 has been plotted from this; allowing 15 pounds drop between the boiler pressure and the initial pressure in the cylinder, so as to cover losses from condensation, wire-drawing, etc. At low speeds this is probably too much, and at high speeds probably not sufficient. Mr. Bach considers, as a matter of fact, that theoretical assessment is impossible. The proportions of the boiler, the class of water used, the type of valve gear, etc., will occur as disturbing factors, but a well proportioned engine may be counted upon to supply steam for a short period on a 75 per cent. cut off for starting purposes, or indefinitely on 60 per cent. at low speeds, and 50 per cent. at moderate speeds. In using these diagrams, therefore, 50 per cent. cut off may be safely assumed for freight, and 33 per cent. for passenger locomotives. Since high speeds and late cut off, and low speeds and early cut off, seldom occur in conjunction, it is possible to get a very near estimate of the actual work any locomotive will do in practice. From the calculated power in the cylinders 10 per cent. should be deducted to cover frictional losses in the machinery, the result being the force available on the rail.

As an example take a two cylinder engine working with 200 pounds per square inch maximum boiler pressure, and having cylinders 18 inches in diameter by 24 inches stroke, with coupled wheels 46 inches in diameter. If a boiler is provided capable of maintaining steam at 15 miles per hour with a 50 per cent. cut off in the cylinder, the engine may be trusted to do the following work in service:

Mean effective pressure (as per Fig. 3) 128 pounds per square inch.

$\dfrac{18 \times 18 \times 24 \times 128}{46}$	21,639 lbs.
Less 10 per cent....................................	2,163 lbs.
Tractive effort	19,476 lbs.

Allowing 10 pounds per ton for journal, rail and atmospheric friction, and 90 pounds per ton for the resistance due to gravity on a 4 per cent. gradient, the engine will haul on that gradient, and at the speed given, 194.7 tons, including its own weight.

In their anxiety to obtain the minimum of weight, with the maximum of adhesion for heavy grade service, many designers have adopted tank engines in preference to tender locomotives. Owing to the very large consumption of water and fuel on these lines, the weight to be carried then generally compels either the use of special types, such as Fairlie or Mallet engines, or the provision of several free carrying axles. It has been found, however, a practical impossibility to design a tank engine having several carrying axles which will maintain even loads on the coupled axles with tanks and bunkers both full and empty. The coupled axles are either overloaded when the tanks are full, or short of adhesion when they are empty.

A tank engine having a certain minimum adhesion, and a certain maximum axle load, can be redesigned as a tender engine with not more than 5 per cent. increase in total weight, provided the capacity for fuel and water remains the same. The advantages of this type are that tenders can be better braked than can running axles on tank engines; and further, troubles with springs and driving boxes, derailments and grinding on curves are all less in the latter type. It would seem, therefore, that the tender engine is likely to prove the better in service.

The use of Fairlie engines, either simple or compound, presents considerations foreign to the use of ordinary tank engines, but many of the objections cited as pertaining to the latter apply also to the Fairlie engines. The high first cost and cost of maintenance is too well known to need more than a mention. In comparing Fairlie engines with ordinary types of tender engines one point often overlooked is the very great difference in the quantity of water and coal carried, which in the tender engine sometimes exceeds 25 per cent. of the total weight on the rails.

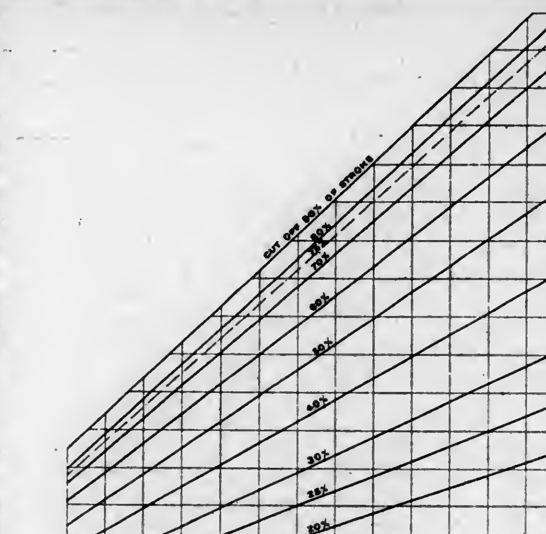


FIG. 3.

Fairlie engines cannot be designed to carry a sufficient amount of fuel and water for long runs, such, for instance, as occur on the Lima-Oroya line of Peru, and they are open to objections applying to variable axle loads on steep gradients.

Mr. Bach does not enthuse over the Mallet compound, saying that in this system the variable load of the Fairlie type seems to have been abolished, only to introduce a number of features more objectional than those its design does away with. It is pointed out that the Baltimore and Ohio 0-6-6-0 Mallet com-

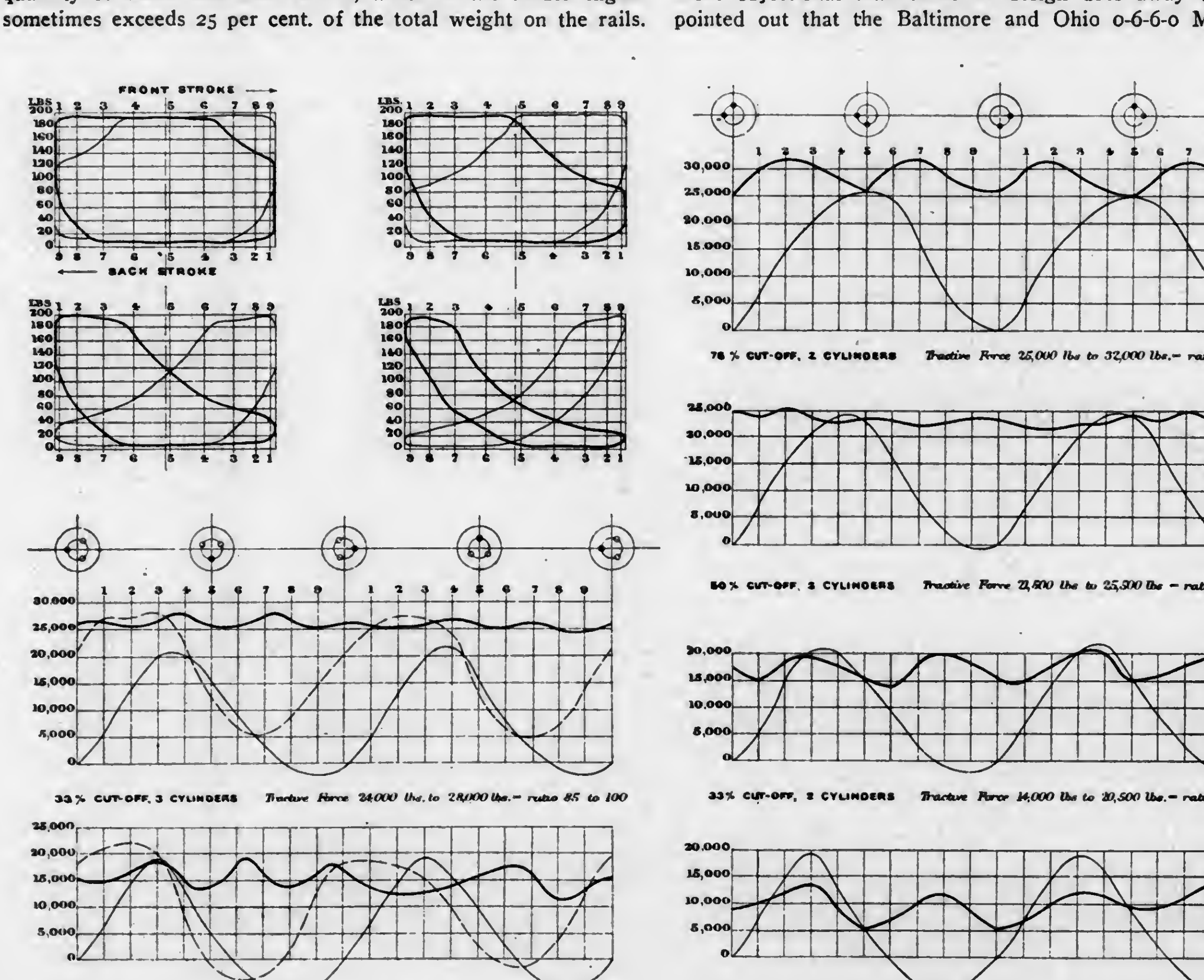


FIG. 4.—DIAGRAMS SHOWING VARIATION IN TRACTIVE POWER.

pound locomotive has cylinders 20 in. and 32 in. diameter, by 32 in. stroke, with 56 in. driving wheels. Calculated by the formula previously given the tractive effort, with a cut-off of 60 per cent. in the high pressure cylinder is approximately 43,000 lbs. at 15 miles per hour.

The engine weighs very nearly 150 tons, on six axles, and a tender suitable for mountain service would need to weigh 70 tons at least, when loaded, or a total of 220 tons. Supposing that such an engine could be worked on a 4 per cent. gradient, it would haul only 430 tons gross, or a train of 210 tons behind the tender. It is a fact that ordinary mogul engines on the Central Railway of Peru, 4 ft. 8½ in. gauge, weighing with tenders 85 tons, are hauling 100 ton trains up such gradients. There are doubtless cases where the track is of light character and the permissible axle load is low, and where steep gradients amount to little more than sharp rises which call for special types of engines; but where loads of 12 tons per axle are allowable, and heavy gradients are continuous, as good or better work in proportion to their weight can be obtained from well-designed tender-engines of the mogul or consolidation type.

The heavy work of hauling on steep gradients allows only very low ratios of expansion to be employed. Even a 50 per cent. cut-off is often difficult to obtain, and to introduce compounding under such circumstances appeals to Mr. Bach as an unwarranted departure, and he affirms that compound Fairlie or Mallet engines are thus open to nearly as serious objections as would be an engine compounded on the Webb system. At low speeds and with heavy loads on these gradients the momentum of the engine and train counts for very little and the ideal engine should have an even and steady torque. This is not obtained with certainty with the separate engines of the Fairlie or Mallet system, as both engines may be in similar positions. With high pressure and low pressure cylinders the work is usually uneven, so that compound engines necessarily waste a considerable portion of their adhesion.

In Fig. 4 the right hand set of curves shows the variation of torque in a two cylinder engine with different ratios of cut-off. These curves have been plotted from the assumed indicator diagrams given, and allowing for a connecting rod equal in length to 8½ times the crank. It will be seen that, even assuming the very favorable condition of even work on both strokes, and in each cylinder, at 75 per cent. of cut-off, the torque ranges from 78 to 100; at 50 per cent. cut-off from 80 to 100, while at 25 per cent. cut-off the range is as much as 39 to 100. In these curves no allowance has been made for the variation in power due to acceleration and retardation of reciprocating parts.

It will thus be appreciated that it is impossible, in a slow running two cylinder engine, for the adhesion to be used efficiently with an early cut-off, yet every ton of excess adhesion on such work represents a considerable percentage of paying load lost. Adhesion must be proportioned to the maximum torque, while the load is limited by the minimum. The provision of four cylinders on separate engines, as in the Fairlie or Mallet systems, does not overcome this objection in the least.

Mr. Bach points out the superiority of the three-cylinder engines which in 1906 he recommended for use on the 4 per cent. gradients of the Central Railway of Peru. The left hand set of curves in Fig. 4 show the variations in torque of a three-cylinder engine, taking the same indicator diagrams as in the two-cylinder type. The cranks are set at 120 degrees, and it will be seen that the tractive effort only varies between 85 and 100, with a 33 per cent. cut-off. At 25 per cent. the variation is between 60 and 100, but as the locomotive is then working well within its adhesive limit, this is of no importance. It is immensely superior to the two-cylinder engine in steam economy, as it can be worked, even in mountain service, with at least three expansions, or as put by the author of the paper, "The Fairlie or Mallet engines should have six cylinders to be equally efficient." The tenor of the paper strongly suggests that three-cylinder engines are more adaptable to heavy grade work, and especially on narrow gauge lines, where the difficulty of designing sufficiently powerful locomotives is daily becoming greater.

It is pointed out that the modern practice of using very large

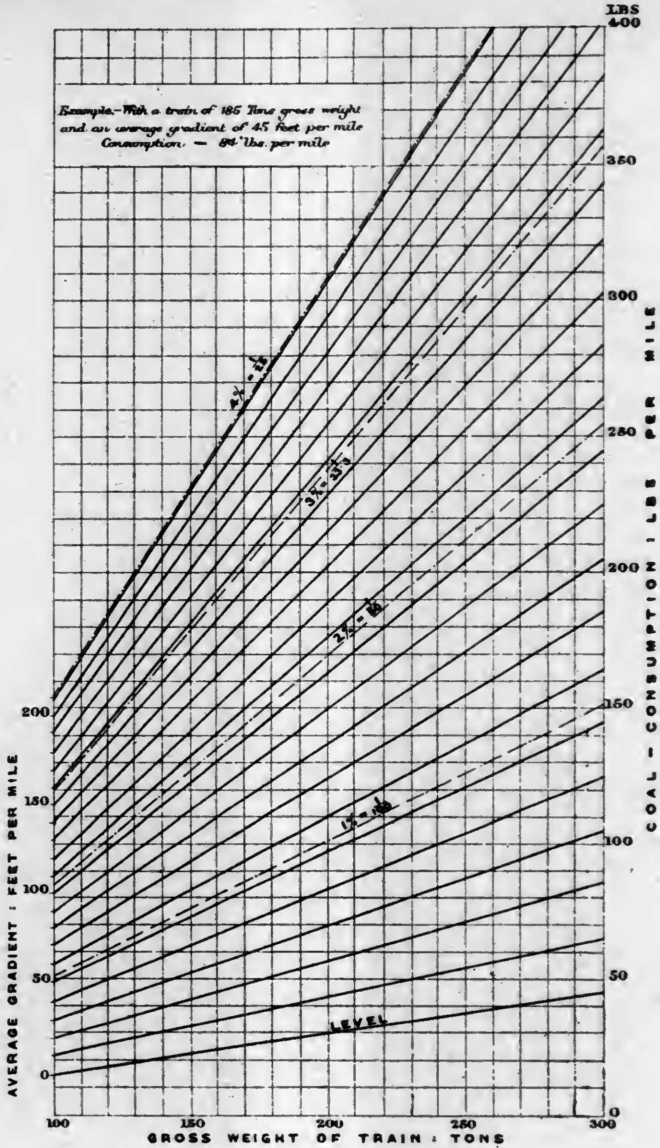


FIG. 5.

boilers is not admissible for heavy gradient working, where weight must be cut down to the lowest point. Practice shows that with reasonably good water and coal it is sufficient to allow one square foot of heating surface for every 15 lbs. of available tractive effort, as worked out by the formula previously given. Mr. Bach emphasizes that great care should be taken in design to keep boiler barrels short and the slope of flue box crowns at least equal to the steepest gradient on which the engines have to work.

For the purpose of determining the grate area required it is necessary to estimate an engine's fuel consumption before commencing to design. Working on slight gradients will be but a poor guide, as in heavy gradient working much unconsumed coal is thrown out of the stack.

The author of the paper has adopted a system of estimating a reasonable consumption by classing the work done under two heads, (1) running as on the level the distance traveled, and (2) raising the total train weight from the lowest level to the heights of the various summits passed. Work on down gradients, owing to radiation, brake consumption, etc., may be taken as equal to work on the level. Under these conditions, and using coal with a calorific value of, say 13,000 B. T. U. per pound, the consumption may be taken at 0.0066 lb. per foot-ton of work done, resistance in the level being taken at 10 lbs. per ton as before. The diagram representedd in Fig. 5 has been prepared on this assumption.

For example, take a train of 185 tons gross weight, including engine and tender, traveling for 50 miles and using 4,500 feet to the summit in that distance, the coal consumption for the round trip, up and down, would be approximately as follows:

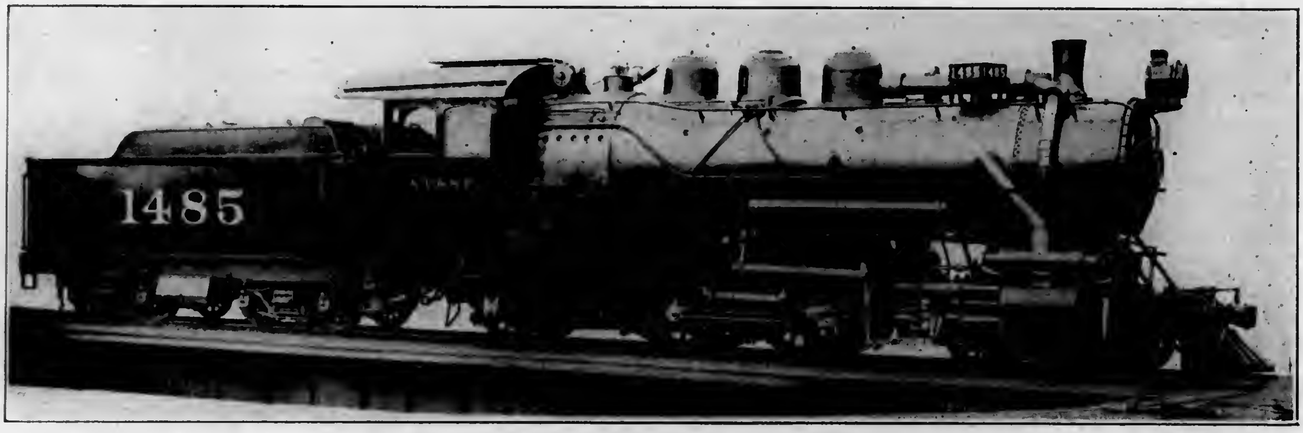
Total distance. 100 miles	= 528,000 feet
Work: $\frac{528,000 \times 10 \times 185}{2,240}$	= 436,100 foot-tons
Plus 185 × 4,500 feet	= 832,500 foot-tons
Total	1.268.600 foot-tons
Coal used = 1,268,600 × 0.0006	= 8,372 lbs.
Total	= 83.7 lbs. per mile

The system differs little from those by which the consumption is estimated on the horse-power developed, but it is more convenient to use. It is pointed out by Mr. Bach in conclusion that the co-efficients should be used only for heavily-loaded engines with little chance of expansive working.

HEAVIEST ATLANTIC TYPE LOCOMOTIVE

ATCHISON, TOPEKA & SANTA FE RY.

Although exceeded in weight on drivers by 4-4-2 engines of both the Erie and the Pennsylvania railroads, the new Atlantics recently completed by the Baldwin Locomotive Works for the Santa Fe are the heaviest of that type yet to be constructed. These engines have a weight of 231,675 lbs., of which the somewhat high proportion of 62,225 lbs., due to the balanced compound feature and reheater, is carried by the leading truck. The weight on the latter thus becomes about 8,000 lbs. greater than in the instance of any other locomotive of this class. The driving wheel base of 6 ft. 10 in. is some three or four inches shorter than that of the average Atlantic, and the weight on trailer reaches the high figure of 57,325 lbs., which is the maximum that has been apportioned to any one pair of wheels on the locomotive, and requires 8 in. x 14 in. journals.



4-4-2 BALANCED COMPOUND LOCOMOTIVE WITH OUTSIDE STEAM PIPES.

As compared with engines of the same type on the Santa Fe these new 4-4-2's embody a change in the design to include the Jacob-Shupert firebox, and of the Buck-Jacobs reheater, which latter is built into the boiler shell and is placed immediately behind the smokebox. The heater contains 417 tubes, 48 in. long, which with a further addition of 30 in. for combustion chamber between the heater and the boiler proper reduces the length of flues to 14 ft. 6 in., and establishes the flue heating surface at 2,318 sq. ft., or 2,508 sq. ft. total. Although comparing somewhat unfavorably in this regard, the figures do not reckon with the reheater surface which exhibits the very large area of 1,147 sq. ft., about five times the heating surface of the superheaters in the previous balanced compounds of this type built for the Santa Fe in 1909.*

A somewhat startling arrangement of steam pipes is a prominent feature in the design, and is clearly indicated in the accompanying illustration. The steam is taken from the boiler at the rear dome and through two 5 in. pipes carried to the forward dome in which the throttle valve is located. The peculiarity of outside pipes begins at this point with an outside dry pipe running on the center line of the boiler. A T-head at the extremity of the dry pipe, immediately behind the stack, provides for the disposition of the steam to the high pressure cylinders. It is said that this arrangement was desired by the railroad, and it became possible through the construction of the reheater. Greater accessibility is of course secured, and this becomes a matter of some importance in connection with the re-grinding of steam pipe joints, but it is quite evident that the symmetrical appearance of the engine has been largely sacrificed for this advantage.

Outside steam pipes will, however, establish one thing, and that, immunity from any poor steaming condition which might result from impaired draft due to leaky joints. It was proposed for years in several quarters to place steam pipes outside to overcome this very trouble, but the prevailing construction of the period made this impossible. Apart from these changes the design is closely similar to that of the previous Santa Fe balanced compounds of this type. Twenty-three locomotives were included in the order.

The general dimensions are as follows. In the ratios no allowance has been made for reheater surface.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pass
Fuel	Oil
Tractive effort	23,800 lbs.
Weight in working order	231,675 lbs.
Weight on drivers	112,125 lbs.
Weight on leading truck	62,225 lbs.
Weight on trailing truck	57,325 lbs.
Weight of engine and tender in working order	405,000 lbs.
Wheel base, driving	6 ft. 10 in
Wheel base, total	32 ft. 8 in.
Wheel base, engine and tender	61 ft. 1 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.7
Total weight ÷ tractive effort	9.7
Tractive effort × diam. drivers ÷ heating surface	692.7
Total heating surface ÷ grate area	52.2
Firebox heating surface ÷ total heating surface	7.5
Weight on drivers ÷ total heating surface	44.7
Total weight ÷ total heating surface	92.3
Total heating surface ÷ vol. cylinders	302.00
Grate area ÷ vol. cylinders	5.70

CYLINDERS.

Kind	Bal. comp.
Diameter and stroke	15 and 25 in. by 26 in.

VALVES.

Kind	Bal. piston

WHEELS.

Driving, diameter over tires	73 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diamater and length	10 x 10½ in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	34¼ in.
Engine truck, journals	6 x 10 in.
Trailing truck, wheels, diameter	47 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Wagon top
Working pressure	220 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	63¾ x 109⅝ in.
Firebox plates, thickness	5/16, 3/8 and 9/16 in.
Firebox, water space	5 and 5½ in.
Tubes, number and outside diameter	273—2¼ in.
Tubes, length	14 ft., 6 in.
Heating surface, tubes	2,318 sq. ft.
Heating surface, firebox	190 sq. ft.
Heating surface, total	2,508 sq. ft.
Superheater heating surface	1,147 sq. ft.
Grate area	48 sq. ft

* See AMERICAN ENGINEER, December, 1909, page 478.

Air Hose Failures

CAREFULLY KEPT RECORDS BY ONE OF THE LARGE TRANS-CONTINENTAL RAILROADS HAVE DEVELOPED MOST INTERESTING AND VALUABLE STATISTICS ON THE LIFE OF AIR HOSE IN SERVICE. THE DATA GATHERED IS PROBABLY MORE COMPLETE THAN ANY HERETOFORE AVAILABLE IN CONNECTION WITH THIS IMPORTANT ITEM IN FREIGHT AND PASSENGER CAR MAINTENANCE.

R. W. Burnett.*

The general question of air hose troubles has been in receipt of considerable attention and investigation in the past, as it is a subject of very great importance in passenger and freight car maintenance, both from the dual viewpoint of economy in supplies and efficiency in operation. Unfortunately, however, the majority of these inquiries appear to have been more largely confined to establishing some carelessness or improper handling of the part in service than in attempting to gather and tabulate such data which would graphically portray all causes of air hose failures. Hence reference tables covering the various ramifications of the problem at a glance have been largely lacking, although it must be evident that when properly prepared from exact records they would not only constitute most valuable addition to the information on the subject of failures, but would serve as the basis for preventive measures to overcome them.

To determine with the greatest possible exactness the cause of all failed hose a careful inspection was made of both air brake and signal hose as it was received at the stripping rack, and it was decided to continue this record over a period of nine months in order that the percentages might be carried to a point where their comparison would prove of the greatest value. This general summary is tabulated herewith, and it will well repay a careful study. The averages in particular have been compiled to show the percentage at a glance of every species of failure, whether occurring in nipple end, center section, or coupling end.

This latter procedure was adopted to determine the part of the hose most liable to fail, and to this end the various sections were given the following length values: nipple end, 5 in.; center section, 12 in., and coupling end, 5 in. Failures were recorded under each heading in the section in which it occurred. "Burst" hose are those which burst without evidences of damage or unfair usage. "Chafed" were hose which had been chafed until they were leaking, or had burst, or were removed because so chafed that they were liable to burst. "Damaged" hose are those which by unfair usage (other than chafed, cut or torn) have failed or burst, and are principally those which by being pulled apart in service have had the inner tube punctured by the end of the nipple, and the hose has as a result failed; or, where the hose has been struck, resulting in the nipple or coupling perforating the inner tube and a failure resulting.

The "cut" hose are those so damaged by being struck and cut by some sharp object, and are of all kinds. "Torn and torn off" hose are largely the result of parting cars without uncoupling the hose. "Porous" hose are what the name implies. "Burnt with steam" are principally hose which have been used in shops and yards on steam connections, or in a few cases are hose which in contact with steam or steam hose have become more or less vulcanized and have in consequence failed. In inspecting these hose close attention was given to estimate the causes of failure and some important deductions can be drawn. Although 5 inches at each end of the hose was considered, the actual failures occurred in about 3 inches at each end, due to the fact that the clamp and inner nipple protect the remaining 2 inches at each end of the hose. This shows then that practically 80 per cent. of the total failures took place within one-third of the total length of the hose. Of the 40 per cent. that failed at the nipple end fully one-half failed within one inch of length either on the inside or outside of the hose.

AVERAGE FAILURES PER MONTH.

Burst	35.30%
Chafed	26.49%
Damaged	18.66%
Cut	2.53%
Torn	4.08%
Porous	5.39%
Burnt	7.55%
Nipple End	39.99%
Center Section	18.85%
Coupling End	41.16%

Burst was the commonest defect. A comparison of the age the hose of different makes removed for this cause gives a good basis for comparison of the quality of the hose. Results of tests made by the test department of sample hose from different consignments, tallied closely with the life of hose removed for this cause. The quality of the rubber, the friction between the layers of canvas, the pliability of the inner tube, etc., are all

RECORD OF AIR HOSE DEFECTS.

Defect		Feb.	March	April	May	June	July	August	September	October	Total	Average Monthly
Burst	Nipple	96	145	344	258	196	352	368	387	617	2763	307
	Centre	13	25	57	47	44	49	69	56	115	475	51
	Coupling	146	207	375	325	447	46	522	463	1016	3547	394
	Total	255	377	776	630	687	447	959	906	1748	6785	753
Chafed	Nipple	39	83	127	90	106	161	117	127	236	1086	120
	Centre	31	68	98	66	78	75	49	109	107	681	75
	Coupling	222	305	458	278	330	488	366	369	503	3319	368
	Total	292	456	683	434	514	724	532	605	846	5086	565
Damaged	Nipple	118	216	335	189	314	351	290	303	485	2781	309
	Centre	5	14	32	15	12	7	22	20	46	173	19
	Coupling	36	81	91	71	78	132	46	35	62	632	70
	Total	159	311	458	275	404	670	358	358	593	3586	398
Cut	Nipple	8	18	18	12	16	12	18	5	44	151	16
	Centre	2	4	20	12	14	3	12	4	4	75	8
	Coupling	11	23	44	25	12	26	47	30	35	253	28
	Total	21	45	82	49	42	41	77	39	83	479	54
Torn and Torn off	Nipple	45	63	232	102	76	62	47	41	67	735	81
	Centre	0	3	3	0	2	0	0	0	0	8	1
	Coupling	2	3	9	3	4	3	3	2	7	36	4
	Total	47	69	244	105	82	65	50	43	74	779	87
Porous	Nipple	3	14	12	5	21	47	17	14	19	152	17
	Centre	41	83	113	60	89	166	62	61	81	756	84
	Coupling	5	3	8	3	9	40	10	19	26	123	13
	Total	49	100	133	68	119	253	89	94	126	1031	115
Burnt with Steam	Nipple	0	0	0	0	0	0	0	0	0	0	0
	Centre	88	197	303	102	156	180	212	96	117	1451	161
	Coupling	0	0	0	0	0	0	0	0	0	0	0
	Total	88	197	303	102	156	180	212	96	117	1451	161

* Gen'l Master Car Builder, Canadian Pacific Ry.

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Fuel	Oil
Tractive effort	23,800 lbs.
Weight in working order	231,675 lbs.
Weight on drivers	112,125 lbs.
Weight on leading truck	62,225 lbs.
Weight on trailing truck	57,325 lbs.
Weight of engine and tender in working order	405,000 lbs.
Wheel base, driving	6 ft. 10 in
Wheel base, total	32 ft. 8 in.
Wheel base, engine and tender	61 ft. 1 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.7
Total weight ÷ tractive effort	9.7
Tractive effort × diam. drivers ÷ heating surface	692.7
Total heating surface ÷ grate area	52.2
Firebox heating surface ÷ total heating surface	7.5
Weight on drivers ÷ total heating surface	44.7
Total weight ÷ total heating surface	92.3
Total heating surface ÷ vol. cylinders	302.00
Grate area ÷ vol. cylinders	5.70

CYLINDERS.

Kind	Bal. comp.
Diameter and stroke	15 and 25 in. by 26 in.

VALVES.

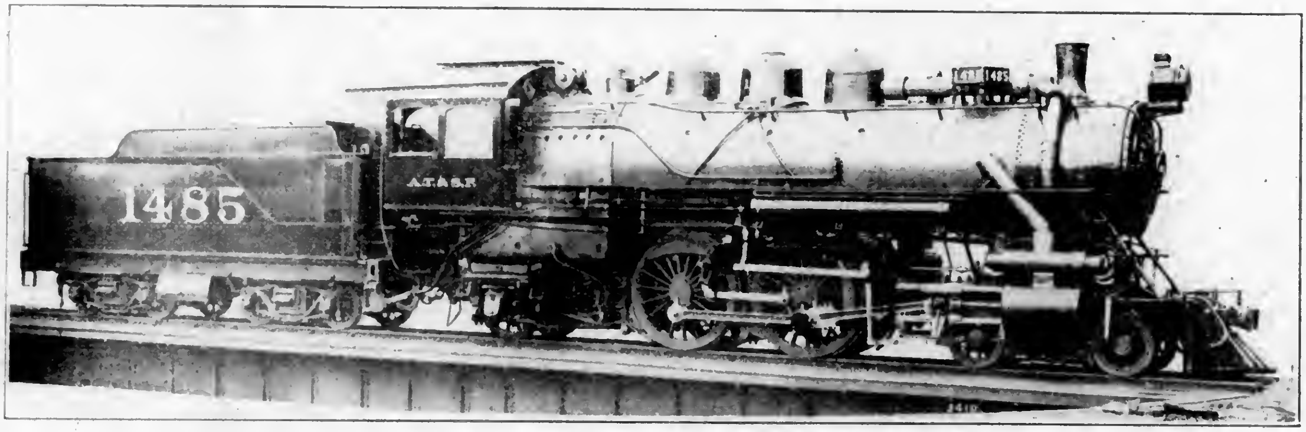
Kind	Bal. piston

WHEELS.

Driving, diameter, over tires	73 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diamater and length	10 x 10½ in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	34¼ in.
Engine truck, journals	6 x 10 in.
Trailing truck, wheels, diameter	47 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Wagon top
Working pressure	220 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	63⅜ x 109⅝ in.
Firebox plates, thickness	5/16, 3/8 and 9/16 in.
Firebox, water space	5 and 5½ in.
Tubes, number and outside diameter	273—2¼ in.
Tubes, length	14 ft., 6 in.
Heating surface, tubes	2,318 sq. ft.
Heating surface, firebox	190 sq. ft.
Heating surface, total	2,508 sq. ft.
Superheater heating surface	1,147 sq. ft.
Grate area	48 sq. ft



4-4-2 BALANCED COMPOUND LOCOMOTIVE WITH OUTSIDE STEAM PIPES.

* See AMERICAN ENGINEER, December, 1909, page 478.

Air Hose Failures

CAREFULLY KEPT RECORDS BY ONE OF THE LARGE TRANS-CONTINENTAL RAILROADS HAVE DEVELOPED MOST INTERESTING AND VALUABLE STATISTICS ON THE LIFE OF AIR HOSE IN SERVICE. THE DATA GATHERED IS PROBABLY MORE COMPLETE THAN ANY HERETOFORE AVAILABLE IN CONNECTION WITH THIS IMPORTANT ITEM IN FREIGHT AND PASSENGER CAR MAINTENANCE.

R. W. Burnett.*

The general question of air hose troubles has been in receipt of considerable attention and investigation in the past, as it is a subject of very great importance in passenger and freight car maintenance, both from the dual viewpoint of economy in supplies and efficiency in operation. Unfortunately, however, the majority of these inquiries appear to have been more largely confined to establishing some carelessness or improper handling of the part in service than in attempting to gather and tabulate such data which would graphically portray all causes of air hose failures. Hence reference tables covering the various ramifications of the problem at a glance have been largely lacking, although it must be evident that when properly prepared from exact records they would not only constitute most valuable addition to the information on the subject of failures, but would serve as the basis for preventive measures to overcome them.

To determine with the greatest possible exactness the cause of all failed hose a careful inspection was made of both air brake and signal hose as it was received at the stripping rack, and it was decided to continue this record over a period of nine months in order that the percentages might be carried to a point where their comparison would prove of the greatest value. This general summary is tabulated herewith, and it will well repay a careful study. The averages in particular have been compiled to show the percentage at a glance of every species of failure, whether occurring in nipple end, center section, or coupling end.

This latter procedure was adopted to determine the part of the hose most liable to fail, and to this end the various sections were given the following length values: nipple end, 5 in.; center section, 12 in., and coupling end, 5 in. Failures were recorded under each heading in the section in which it occurred. "Burst" hose are those which burst without evidences of damage or unfair usage. "Chafed" were hose which had been chafed until they were leaking, or had burst, or were removed because so chafed that they were liable to burst. "Damaged" hose are those which by unfair usage (other than chafed, cut or torn) have failed or burst, and are principally those which by being pulled apart in service have had the inner tube punctured by the end of the nipple, and the hose has as a result failed; or, where the hose has been struck, resulting in the nipple or coupling perforating the inner tube and a failure resulting.

The "cut" hose are those so damaged by being struck and cut by some sharp object, and are of all kinds. "Torn and torn off" hose are largely the result of parting cars without uncoupling the hose. "Porous" hose are what the name implies. "Burnt with steam" are principally hose which have been used in shops and yards on steam connections, or in a few cases are hose which in contact with steam or steam hose have become more or less vulcanized and have in consequence failed. In inspecting these hose close attention was given to estimate the causes of failure and some important deductions can be drawn. Although 5 inches at each end of the hose was considered, the actual failures occurred in about 3 inches at each end, due to the fact that the clamp and inner nipple protect the remaining 2 inches at each end of the hose. This shows then that practically 80 per cent. of the total failures took place within one-third of the total length of the hose. Of the 40 per cent. that failed at the nipple end fully one-half failed within one inch of length either on the inside or outside of the hose.

AVERAGE FAILURES PER MONTH.

Burst	35.30%
Chafed	26.49%
Damaged	18.66%
Cut	2.53%
Torn	4.08%
Porous	5.39%
Burnt	7.55%
Nipple End	39.99%
Center Section	18.85%
Coupling End	41.16%

Burst was the commonest defect. A comparison of the age the hose of different makes removed for this cause gives a good basis for comparison of the quality of the hose. Results of tests made by the test department of sample hose from different consignments, tallied closely with the life of hose removed for this cause. The quality of the rubber, the friction between the layers of canvas, the pliability of the inner tube, etc., are all

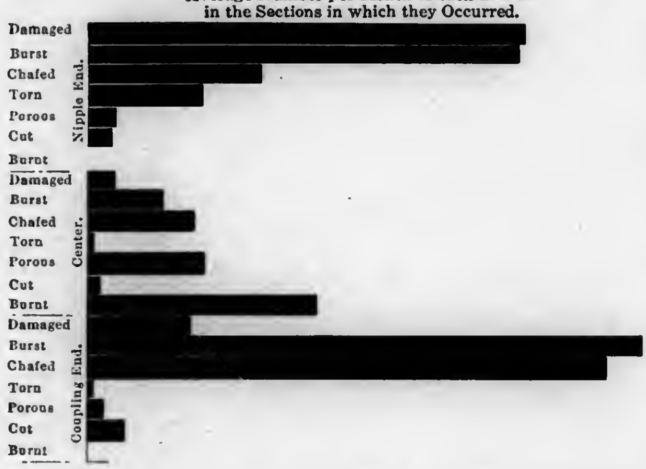
RECORD OF AIR HOSE DEFECTS.

Defect		Feb.	March	April	May	June	July	August	September	October	Total	Average Monthly
Burst	Nipple	96	145	344	258	196	352	368	387	617	2763	307
	Centre	13	25	57	47	44	49	69	56	115	475	51
	Coupling	146	207	375	325	447	46	522	463	1016	3547	394
	Total	255	377	776	630	687	447	959	906	1748	6785	753
Chafed	Nipple	39	83	127	90	106	161	117	127	236	1086	120
	Centre	31	68	98	66	78	75	49	109	107	681	75
	Coupling	222	305	458	278	330	488	366	369	503	3319	368
	Total	292	456	683	434	514	724	532	605	846	5086	565
Damaged	Nipple	118	216	335	189	314	351	290	303	485	2781	309
	Centre	5	14	32	15	12	7	22	20	46	173	19
	Coupling	36	81	91	71	78	132	46	35	62	632	70
	Total	159	311	458	275	404	670	358	358	593	3586	398
Cut	Nipple	8	18	18	12	16	12	18	5	44	151	16
	Centre	2	4	20	12	14	3	12	4	4	75	8
	Coupling	11	23	44	25	12	26	47	30	35	253	28
	Total	21	45	82	49	42	41	77	39	83	479	54
Torn and Torn off	Nipple	45	63	232	102	76	62	47	41	67	735	81
	Centre	0	3	3	0	2	0	0	0	0	8	1
	Coupling	2	3	9	3	4	3	3	2	7	36	4
	Total	47	69	244	105	82	65	50	43	74	779	87
Porous	Nipple	3	14	12	5	21	47	17	14	19	152	17
	Centre	41	83	113	60	89	166	62	61	81	756	84
	Coupling	5	3	8	3	9	40	10	19	26	123	13
	Total	49	100	133	68	119	253	89	94	126	1031	115
Burnt with Steam	Nipple	0	0	0	0	0	0	0	0	0	0	0
	Centre	88	197	303	102	156	180	212	96	117	1451	161
	Coupling	0	0	0	0	0	0	0	0	0	0	0
	Total	88	197	303	102	156	180	212	96	117	1451	161

* Gen'l Master Car Builder, Canadian Pacific Ry.

important. The life of hose bursting in the center section was, as a rule, high; in a number of hose examined it averaged about five or six years, some hose going as high as eight years. Damaged hose are peculiar. They are generally caused by being forced against the end of the nipple connection by being struck, or by hose being pulled apart, resulting in the inner tube of the hose being perforated and often the outer covering damaged as well, in which case the failure occurs at that point. In other cases, where the inner tube only is damaged, the air works

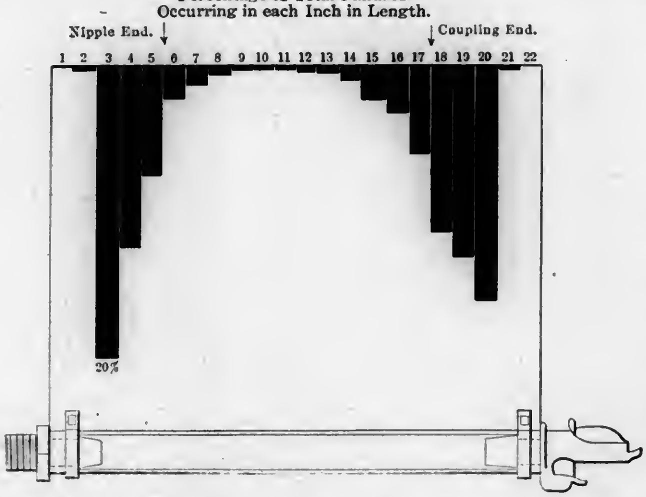
Average Number per Month of each Defect in the Sections in which they Occurred.



between the layers of canvas gradually loosening successive layers or ply, and ultimately bursting in the weakest spot. Some peculiar cases were noticed of hose which had appeared to have burst from chafing near the coupling end, but which had in reality burst through the perforating of the inner tube at the nipple end, the air burrowing between the layers of canvas and finding an outlet at this point ;

Chafed hose are almost entirely off passenger equipment, the greater majority of both passenger brake and signal hose being removed for this cause. The signal hose are particularly liable to damage from this chafing, due to the scant clearance between the various hose in service. By far the greater number occur at the coupling end. The cut hose require no discussion. The torn and torn off hose are largely the result of cars parting with-

Percentage of Total Failures Occurring in each Inch in Length.



out the hose being uncoupled. Porous hose have many causes, manufacturers' defects, hose pulled apart and other conditions of service; but they are a serious defect to allow to remain in service. Tests have been made of porous hose which have been allowed to remain in service in yards for six months without becoming appreciably worse, while others have burst in a short time. The importance of soap sud tests of hose in trains and on repair tracks is evident. Air hose on account of their convenient couplings are largely used in shops and yards on steam connections. These form a large percentage of the hose which have failed from being burnt with steam, and while not a large percentage to the whole, yet on account of the short time they last, are a considerable influence in reducing the average life of the hose.

Careful consideration of the best means of increasing the average life of the hose led to the following deductions:

The age of the burst hose can best be lengthened by using hose of the best quality and by careful tests of samples to see that the hose supplied are fully up to specification.

The chafed hose can be lessened by careful maintenance of passenger cars, to see that they are at the proper height and that the location of all hose connections and their angle is kept closely standard.

Damaged hose can be lessened by seeing that hose are always parted by hand in uncoupling cars. A considerable number of the porous and damaged hose are also caused by hose being pulled apart.

In one table is given a graphical demonstration of the parts of the hose most liable to fail. Exact figures could not be obtained, but the percentages are approximately correct. It was not possible to separate the various classes of hose, but it may safely be said that signal hose generally fail at the coupling end from chafing. Passenger brake hose usually fail from chafing at the coupling end. Freight hose fail more often at the nipple, and either from bursting or from pulling hose apart or from bursting at the point near the coupling where the hose is most bent in coupling and uncoupling.

DEMONSTRATION OF MACHINE TOOLS AT YALE

In the new Mason laboratory of mechanical engineering at Sheffield Scientific School, Yale University, which is under construction and will be completed early next summer, there is a large room reserved for the exhibition of modern machines of special or complex design. Power will be available for the operation of such machines as may be placed there, and it is expected that representatives of the company building the machine will be present to demonstrate its working at certain specified times. This is an original idea which will no doubt prove to be of great benefit to both the students and the machine tool manufacturers, who can in this way personally demonstrate their machine to prospective future buyers. The arrangement of the building is such that machines can be easily installed and removed, as may be required.

This new laboratory is to be one of the most complete that has ever been erected for the purpose. The funds for its erection were furnished by two graduates of the school, after whom it is named. It will contain no recitation or drawing rooms, and its three floors, measuring about 85 x 205 ft., will be devoted almost entirely to research and general experimental work.

THE CONSTRUCTION OF NEW ROLLING STOCK during 1910 indicates a fairly healthy condition of the railway supply business, as the cars built totaled over 185,000, being practically twice the number constructed in 1909 and more than 100,000 in excess of those built in 1908. The 1907 total, however, was 289,000, and that for 1906, 243,000. The 1910 output was divided into 181,000 freight cars and about 4,500 passenger cars. The passenger car output has only been exceeded once in the history of passenger car construction, namely, in the year 1907, when 5,457 cars were built. Locomotive construction also made a fairly good showing, the total number of engines built being 4,700. This number being exceeded only in the years 1903, 1905, 1906 and 1907.

CAR SERVICE IN 1910.—For the current calendar year car service operations will total one of the largest movements in the country's transportation records. Official figures are at hand up to and including October. If the operations for November be placed at 3,250,000 cars, and those for December at 2,750,000, which are not quite so large as those of 1909, we shall have handled by the 35 leading car service bureaus in 1910 a total of 35,454,588 cars. This is 10 per cent. larger than the corresponding total of 1909. In that year 32,011,362 cars were reported by the various demurrage bureaus.

Standard Wheel Centers and Tires

THE IMPORTANCE OF SECURING SELF ADJUSTMENT FOR LOCOMOTIVE DRIVING TIRES THROUGH THE EMPLOYMENT OF SPECIALLY PREPARED WHEEL CENTERS IS COMMONLY RECOGNIZED, BUT THE DIFFICULTIES WHICH LIE IN THE WAY OF SO STANDARDIZING EXISTING CENTERS RENDER THE SCHEME LARGELY IMPRACTICABLE

For many years the argument has been steadfastly advanced that it would be eminently fitting and to the point if uniformity could be established between locomotive tires and the centers which must carry them. One halcyon dream from the days almost of the pioneer Ross Winans to the present has been that the component parts of a locomotive might be so designed as to permit the assemblage of tires for a certain engine on the mere mention of its name and class. Or, to more clearly indicate, should a certain engine want tires, look at her number and class, as defined by the headlight, badge plate and other accessories, go to the tire rack, pick the tires out, and apply them without the consideration of a mistake or the use of a gauge, no matter how visionary and elusive certain underlying factors in the said application might be.

This is an important consideration with the majority of railroads, and it should be so viewed in connection with all of them, because tire setting, or properly "spacing," is a vital problem which cannot be too lightly approached. Improper spacing means cut flanges, distorted rods, and many other manifestations which are inimical towards successful locomotive maintenance. If improper spacing is in evidence it must be due to the men or to the shop which sets the tires, and if the evil of improper spacing must continue, then corrective measures must be looked for in a scheme of tire setting which will render the process entirely mechanical, and which in itself will effectually safeguard against any possibility of error, no matter how careless may be the attitude in which the work is approached. The idea in brief is to make standard the dimensions between the inside and outside faces of driving wheel rims for each of the various classes of locomotives which the road may have, and in a similar manner standardize the boring of the tires, so that when applied they must be to transverse gauge and properly spaced without the necessity of any measurement.

This, of course, implies that the tires will be "lipped." There must be an offset to the bore on the outer face of, say $\frac{3}{8}$ in. wide by $\frac{1}{8}$ in. deep, and this will afford something to come up against the outside face of the driving wheel center rim when the tire is slipped on the latter to position. All that is necessary under such an ideal condition is to heat the tire and apply, and no need to run around the engine with gauges to see that the various tires are spaced in accordance with existing instructions.

No argument is necessary in regard to the desirability of this feature, and it could no doubt in time be brought about, but the obstacles in the way are worthy of consideration. The matter of standardizing the tires presents few, if any, difficulties, but the opposite is the case when the center itself is taken under consideration. For instance, assuming a railroad of doubtful age with, say, 1,500 locomotives. To enjoy possession of that amount of power the road must have been in existence for many years. Its locomotives must necessarily have cast iron centers, some steel centers, maybe, but, at all events, old centers of the utmost variety in design. They were all evolved with the simple idea of a rim faced straight across the top for the reception of the tire, the setting of the latter in relation to its mate on the corresponding wheel across the engine to be entirely at the discretion of the persons applying it. In some cases after a tire had been applied it would hang over the outside face of the rim possibly $\frac{3}{4}$ in., while in other cases it would be flush or maybe inside the rim. These discrepancies may well illustrate that existing centers do not lend themselves readily to standardization following the lipped tire idea.

To bring this latter about, when the locomotive is in receipt of such repairs where the wheels are removed it is necessary to take each pair of the latter to the lathe and face entirely off the outside of the rim sufficient metal to compensate for the width of the lip to be left on the tire. In other words, presuming that the tires are a standard width of 4 in., and the width of lip considered best is $\frac{3}{8}$ in., then the portion of the tire above the lip must be $3\frac{5}{8}$ in. wide, this portion representing its shrinkage or bearing surface. If the top of the wheel center were also 4 in. wide it would be a comparatively easy matter, at first thought, to face the necessary $\frac{3}{8}$ in. off the outside face of the rim, thus allowing the tire to bring the inner edge of its lip against that surface, and provide an even $3\frac{5}{8}$ in. shrinkage area for both tire and center.

On this erroneous and fallacious presumption the promoters of this idea would no doubt base their claims, but the significant fact arises that scarcely one wheel center in one hundred, especially on an engine some years of age, will permit such treatment. In the first place the distance between the inner faces of rims on a single pair of wheels will always be found excessive, and this, of course, if no other obstacle intervened, would detract so much from the bearing surface of each tire. Supposing this discrepancy, for instance, equaled a total of $\frac{1}{2}$ in., and this is nothing, as differences of $1\frac{1}{4}$ in. have been noted, then each tire would be deprived of $\frac{1}{4}$ in. bearing. To this also must be added the $\frac{3}{8}$ which must be faced from the outside of the rim in order that the lip of the tire may come up solid against it, or, with a 4 in. tire, its bearing or shrinkage area is reduced to $3\frac{3}{8}$ in., an insufficient surface to hold it properly where heavy braking is in evidence.

The question of the discrepancy in dimensions between the inner faces of center rims is, however, the least of the obstacles which will be encountered. The facing of the outer rim is a far more serious proposition for two reasons. First, if the centers are too far apart it will mean a very heavy cut to be taken from the rim. Under ideal conditions in this treatment it would be $\frac{3}{8}$ in., but in the face of primary improper center spacing it might arise to even 1 in. Comment in this case is superfluous, because it will be readily appreciated that one inch removed from the outside of a center rim would take the cut into the spokes themselves, and weaken the center to the point of uselessness. It may be said here that in almost every instance where this general scheme has been attempted such a condition arose. In some thousand or more centers examined on one occasion there was not one so placed on the axle that a mere $\frac{3}{8}$ in. faced down would bring the lipped tire to gauge. It was always much more than this; in some instances twice as much.

The second obstacle is this: some driving wheel centers have a very high counterbalance, extending in fact to even with the top of the rim. The ordinary tire slips over this, of course, to its proper position on the center, but the lipped tire will not do so. In facing down the outside of a rim with this form of counterbalance it will be readily appreciated that a tremendous amount of metal must be turned off the top of the latter, otherwise the tire could not be applied. This turning would disturb the weight of the counterbalance to an appreciable extent, and it would also, in the instance of the design of the majority of wheels, expose the core also.

From what has been said it will be appreciated that it would be difficult if not impossible to apply a standard tire, 4 in. wide, with a $\frac{3}{8}$ in. lip, to existing wheel centers. While it might work in some instances by sacrificing the strength of the center, in 90 per cent. of cases it will not, no matter what sacrifices be

made. It goes without question that the idea is beyond reproach. With the centers properly faced, and the tire properly lipped, new tires would be self-adjusting in regard to opposite sides of the engine immediately on application, and no chance for error could possibly exist in performing the important operation known as tire spacing.

There is no doubt but that improprieties in this latter regard are responsible for more cut driving tire flanges than any other cause, and this is what the lipped tire idea is fundamentally intended to correct. It is to take the matter of measurement entirely away from the roundhouse or back shop forces who are charged with the application of the tires by a construction of both the tires and center which in combination must insure that the former go exactly to their proper position on the center, and the operation of tire setting so simplified that it could be entrusted to the commonest form of labor.

Before any railroad attempts this, however, it would be more to the point to have the centers gauged for their distance apart on every engine of the railroad as a preliminary. This is a much cheaper and much more common-sense plan than to have the master mechanics cutting the wheel centers to pieces in the attempt to follow instructions which could not possibly be applied to cover all cases. If it is found, following this inspection, that the large majority of centers through inequalities in design do not admit of standardization, then the entire matter should be discarded until the existing wheel centers have been redesigned to meet the proposed new conditions.

With redesigned wheel centers properly spaced in relation to one another on the same axle, and with rims 3⅝ or 4 in. wide, requiring no treatment on the outside face of the rims, conditions become at once ideal, as the question of machining the tires is nothing.

PENNSYLVANIA EQUIPMENT FOR 1910

The locomotive equipment ordered by the Pennsylvania Railroad with its controlled and subsidiary lines during 1910 is of special interest in the illustration afforded of the requirements of an up-to-date system and the quality of power necessary to meet them. In the following list the locomotives listed are those intended for the Pennsylvania Railroad, including the W. N. Y. & P. Ry. and the P. & N. W. R. R.:

No.	Cylinders.	Eng. Wt.	Type.	S. or C.	Builder.
80	24" x 28"	238,300	2-8-0	Simple	Baldwin
34	24" x 28"	238,300	2-8-0	"	P. R. R. Co.
16	18½" x 24"	116,500	0-4-0	"	"
8	20" x 24"	114,100	0-6-0	"	"
56	24" x 26"	272,000	2-6-4	"	"

For the Philadelphia, Baltimore and Washington Railroad the locomotives ordered were as follows:

No.	Cylinders.	Eng. Wt.	Type.	S. or C.	Builder.
6	20" x 24"	144,100	0-6-0	Simple	P. R. R. Co.
1	22" x 26"	214,500	4-4-2	"	"
6	24" x 26"	272,000	2-6-4	"	"

It will thus be noted that a total of 207 locomotives was ordered, 127 of which were built by the Pennsylvania Company at its Juniata shop. The car equipment ordered is also worthy of special mention, comprising a total of 266 coaches, combination, express, baggage and mail cars, and 883 freight cars. Of the first mentioned equipment the Pennsylvania Company built 17 baggage-mail, 25 baggage and 5 dining cars at its Altoona car shops, and the company also took care of the construction of over 600 of its new freight cars.

Notwithstanding the Many Adverse Conditions with which the railroads had to struggle in 1910, their new construction work compares favorably with that of the past two years as a total of over 4,000 miles was added as against 3,700 in 1909, and 3,200 in 1908. As compared with the average for the past ten years, however, the showing is not so favorable, there being a decrease of approximately seven hundred miles. The receivership record indicates very little financial difficulties during the year, the number of roads involved being only seven, with a total length of 735 miles.

NEW SELF-DISCHARGING HOPPER BALLAST CAR

BUENOS AYRES WESTERN RY.

On the Buenos Ayres Western Railway system, which consists of 1,460 miles, 5 ft. 6 in. gauge track in Argentina, fifty self-discharging hopper cars of an entirely new design are now being introduced into service for ballasting purposes. The scarcity of labor in that country at certain times of the year had much to do in influencing the design, which had for the principal end in view an arrangement which would require the minimum of attention in its operation. These cars exhibit considerable variation from the usual foreign constructive ideas in this regard and many details can be recognized which are closely akin to distinctive American practice.

This latter is particularly noticeable in the trucks. These are of the plain arch bar, or diamond frame type, a construction which is fast supplanting the time-honored rigid pedestal arrangement which has heretofore been so prominent abroad even in instances of exceedingly long wheel base. The arch-bar truck is, in fact, standard on all railroads of the Argentine republic. With the exception that the trucks were specified by the railroad company, the design was accepted after a competition between several of the leading rolling stock manufacturers, and in which the Leeds Forge Co., Limited, of Leeds, England, were awarded the contract.

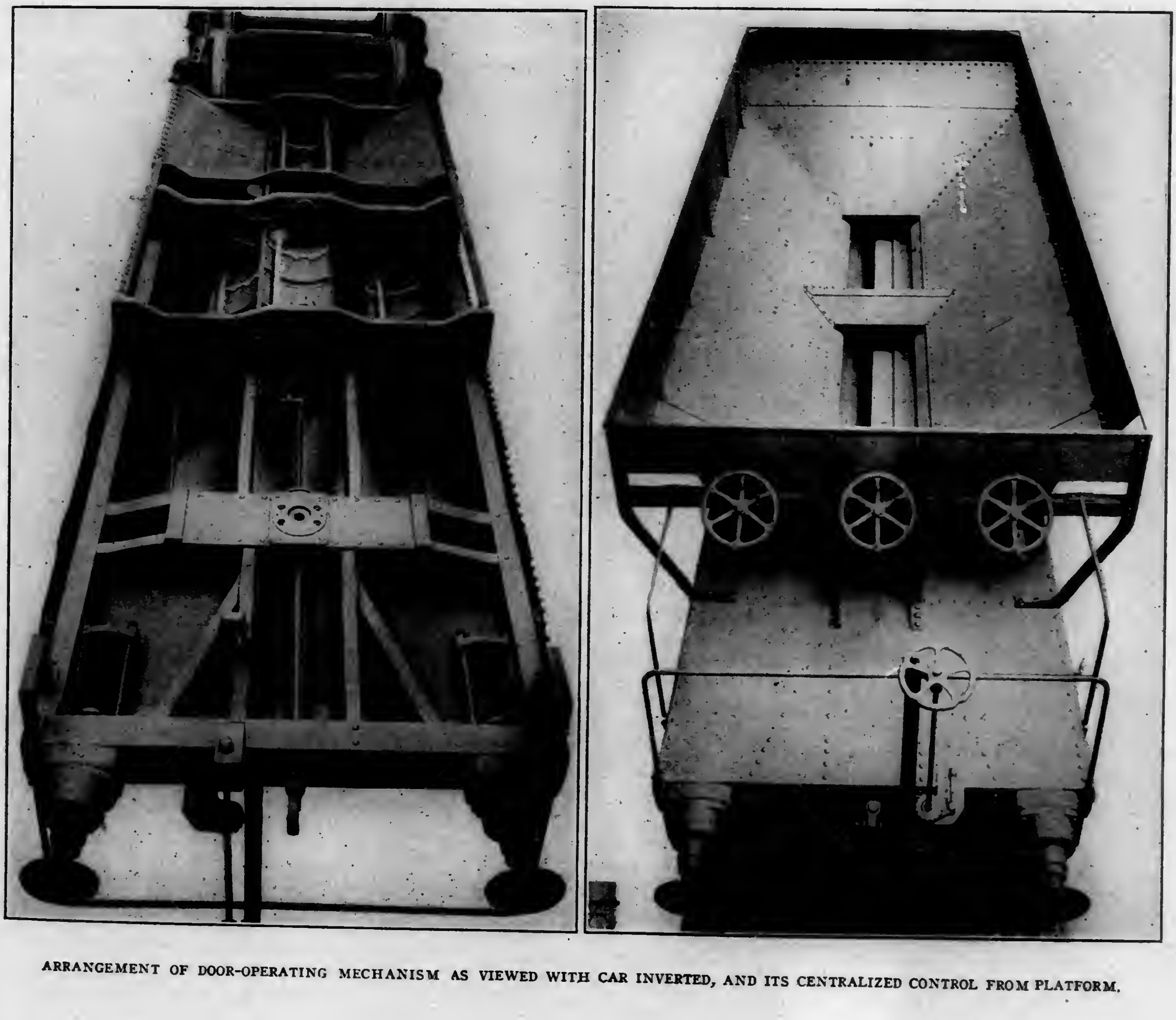
The salient feature of the new design lies in the fact that each of the cars is arranged to discharge its contents in whatever direction is required, whether at one side or the other, in the center, or in different directions simultaneously, and so that the rate of discharging can be regulated and stopped when required. The arrangement of the doors is clearly shown in the photo taken underneath the car after one of the trucks had been removed, and also the side and center chute plates removed from the nearest doorway. In the far doorway these chute plates have been left in position, and they consequently obscure the view of the side doors. It will be seen that each set of doors can be opened, regulated and closed independently of the others; that the operating gear is extremely simple, that it is not likely to get out of order, and is therefore economical in upkeep. The opening and closing of the doors and the amount of material deposited is entirely under the easy control of the operator standing on the platform of the car.

The cars are of all steel construction with underframes of the Leeds Forge Co.'s pressed steel pattern. The arrangement of the side and corner stakes, assisted by the diagonal bracing between the frame and hopper body, provides the maximum of strength and rigidity, and in the event of damage to the car the parts show unusual accesibility for removal. It will be noted that the underframe is braced with exceptional strength at the end sill, for a car intended for this purpose, and that the underframe construction in general has been worked out with an entire absence of complication.

The cars have each a cubical capacity of 880 ft., sufficient for a working load of 89,600 lbs., and the weight light is 35,840 lbs. The length over buffers is 34 ft., 11¼ in.; over end sills, 31 ft. 3 in.; height over all, 9 ft., and width, 10 ft., 8 in. The buffer height unloaded is 41 in. The trucks have 33 in. steel tired wheels of 66 in. wheel base, and are spaced 21 ft. 9 in. from center to center. The inside dimensions of the hopper or body are length 23 ft., and width 10 ft. 6 in. The wheel diameter is 33 in.; truck wheel base 5 ft. 6 in., and total wheel base 27 ft. 3 in.

The distribution of materials by this car leaves nothing to be desired, and it can be regulated to a nicety at whatever speed the car is propelled. The leveling of the ballast which remains after unloading can be readily handled by two or three men which implies a heavy reduction in the construction force ordinarily employed in connection with the former methods in vogue for unloading.

SELF-DISCHARGING HOPPER BALLAST CAR SELECTED FROM COMPETITIVE DESIGNS SUBMITTED BY VARIOUS EUROPEAN BUILDERS.



ARRANGEMENT OF DOOR-OPERATING MECHANISM AS VIEWED WITH CAR INVERTED, AND ITS CENTRALIZED CONTROL FROM PLATFORM.

New Frisco Locomotive for Pusher Service

THE FIRST 2-8-8-2 TYPE TO BE PRODUCED BY THE AMERICAN LOCOMOTIVE COMPANY EMBODIES A NEW DEPARTURE IN STEAM PIPE ARRANGEMENT WHICH IS OF PARTICULAR INTEREST.

The rapid growth in favor of the Mallet locomotive has served to establish as truths many items of design which had hitherto been largely viewed on a speculative basis, or at least as still in the experimental stage. Prominent in this connection, where doubt has been succeeded by approval, is exhibited in boiler development which this type of locomotive logically brought about with its adoption into American practice.

HEAVY MALLET LOCOMOTIVE FOR FRISCO LINES.

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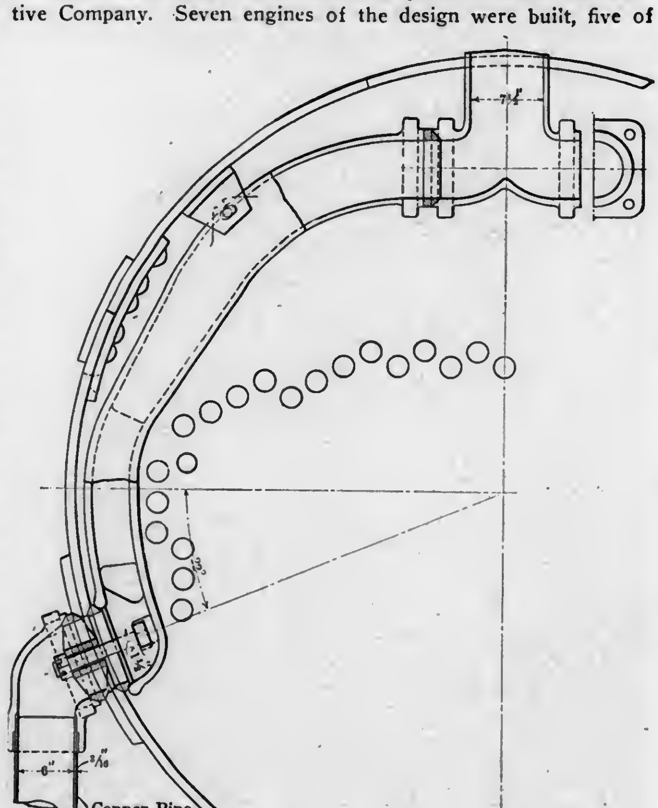

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The general dimensions are as follows:

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Gauge	4 ft. 8½ in.
Service	Pusher
Fuel	Bit. coal
Tractive power	83,300 lbs.
Weight in working order	418,000 lbs.
Weight on drivers	360,000 lbs.
Weight of engine and tender in working order	567,600 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, total	56 ft. 8 in.
Wheel base, engine and tender	85 ft. 6¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	5.01
Tractive effort × diam. drivers ÷ heating surface	919.85
Total heating surface ÷ grate area	68.45
Firebox heating surface ÷ total heating surface, %	6.11
Weight on drivers ÷ total heating surface	69.93
Total weight ÷ total heating surface	80.97
Volume equivalent simple cylinders, cu. ft.	25.50
Total heating surface ÷ vol. equiv. cylinders	202.42
Grate area ÷ vol. equiv. cylinders	2.95
CYLINDERS.	
Kind	Articulated compound
Diameter	24½ and 39 in.
Stroke	30 in.
VALVES.	
Kind, H. P.	Piston
Kind, L. P.	Slide
Greatest travel	6 in.
Outside lap, H. P.	1 in.
Outside lap, L. P.	1 in.
Inside lap	5/16 in.
Lead in full gear	3/16 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheels, diameter	30 in.
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BOILER.	
Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	81⅝ in.
Firebox, length and width	120⅛ x 90¼ in.
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Firebox, water space	5 in.
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Tubes, length	24 ft.
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New Frisco Locomotive for Pusher Service

THE FIRST 2-8-8-2 TYPE TO BE PRODUCED BY THE AMERICAN LOCOMOTIVE COMPANY EMBODIES A NEW DEPARTURE IN STEAM PIPE ARRANGEMENT WHICH IS OF PARTICULAR INTEREST.

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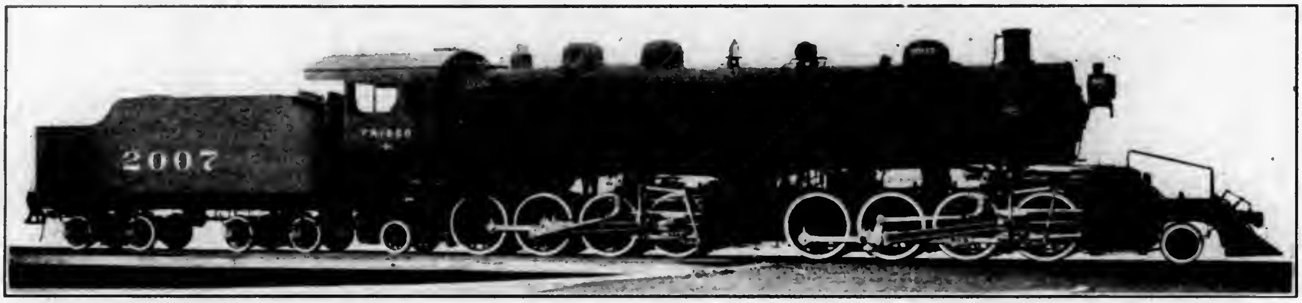

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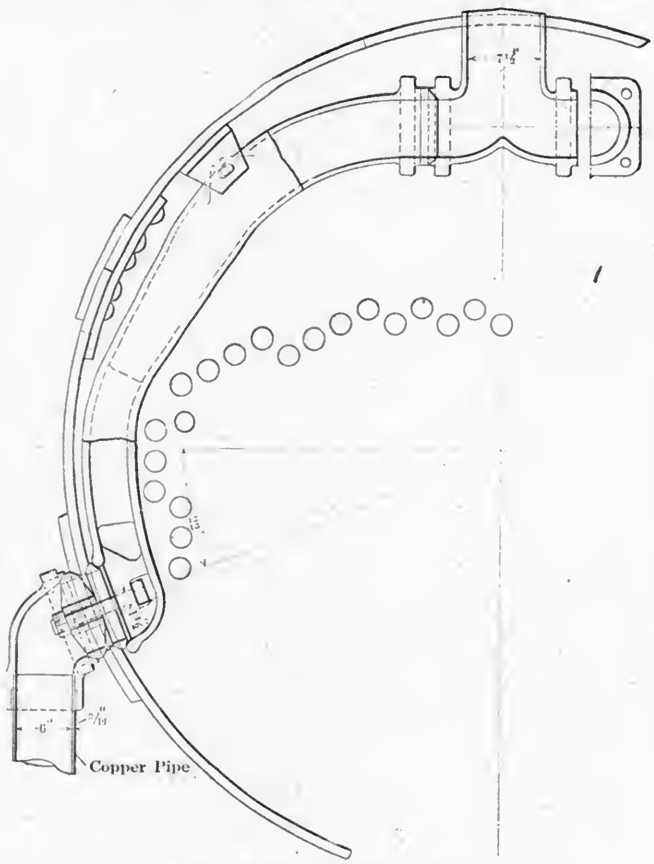

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The General Oil House of the Santa Fe

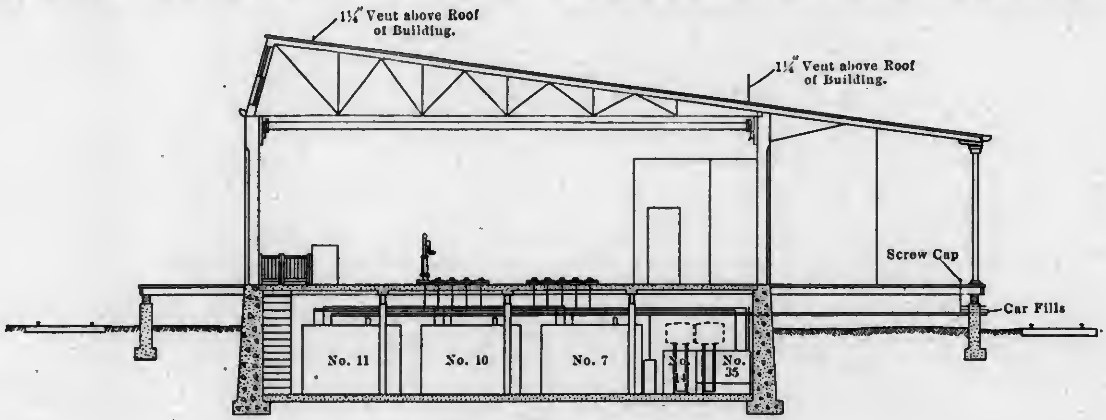
THE LARGEST INSTALLATION YET TO BE MADE IN THIS COUNTRY HAS RECENTLY BEEN COMPLETED AT TOPEKA, KANS., ON THE ATCHISON, TOPEKA & SANTA FE RAILWAY. SELF MEASURING OIL PUMPS CAPABLE OF TRANSFERRING 300,000 GALLONS IN TEN HOURS PROVIDE SUFFICIENT CAPACITY TO TAKE CARE OF OIL DISTRIBUTION FOR THE ENTIRE RAILROAD SYSTEM.

In the general betterment of existing shop facilities, which has been such a prominent feature in connection with railroad operation during the past few years, the very necessary adjuncts, oil storage and distributing plants, have not by any means been neglected. Although the development of these structures has probably not progressed with the rapidity so characteristic of machine and erecting shop, or even roundhouse rehabilitation, still much has been accomplished by designers, and many installations have been made which well illustrate the importance now associated with this particular feature.

One of the most elaborate of recent designs is that of the general oil storage house of the Atchison, Topeka and Santa Fe Railway, which has recently been completed in connection with that company's principal store and shops at Topeka, Kans. As these latter are regarded as system shops, the oil house is also so designated. It constitutes the depot for distribution of lubricating and illuminating oil to all parts of the railroad, and in its size and the completeness of its detail it becomes at once the finest equipped building of the kind as well as the largest ever constructed in this country, if not in the world. The storage capacity reaches the enormous total of 150,000 gallons, this including paints and such oils as raw and boiled linseed, turpentine, etc.

With this new improved oil house and storage plant the Santa Fe is enabled to transfer oil from foreign line cars to its own at Topeka, thereby cutting out the mileage and per diem charges on foreign cars. Under the old system the cars were sent to the farthest point on the line, Richmond, Cal., or south to El Paso and Galveston, and by the time the car returned home the road had from $25 to $35 charges covering it. The extra expense has been entirely eliminated, and in connection with the new plant the Santa Fe has now 35 cars of its own in service for the handling of headlight, mineral, seal, signal, engine, car and valve oil.

Before discussing the installation of the building, which is of particular interest in view of its magnitude, and the exceedingly clever arrangement embodied, several prominent features in connection with the structure itself should not be passed un-



ELEVATION ON PLAN LINE B-B.

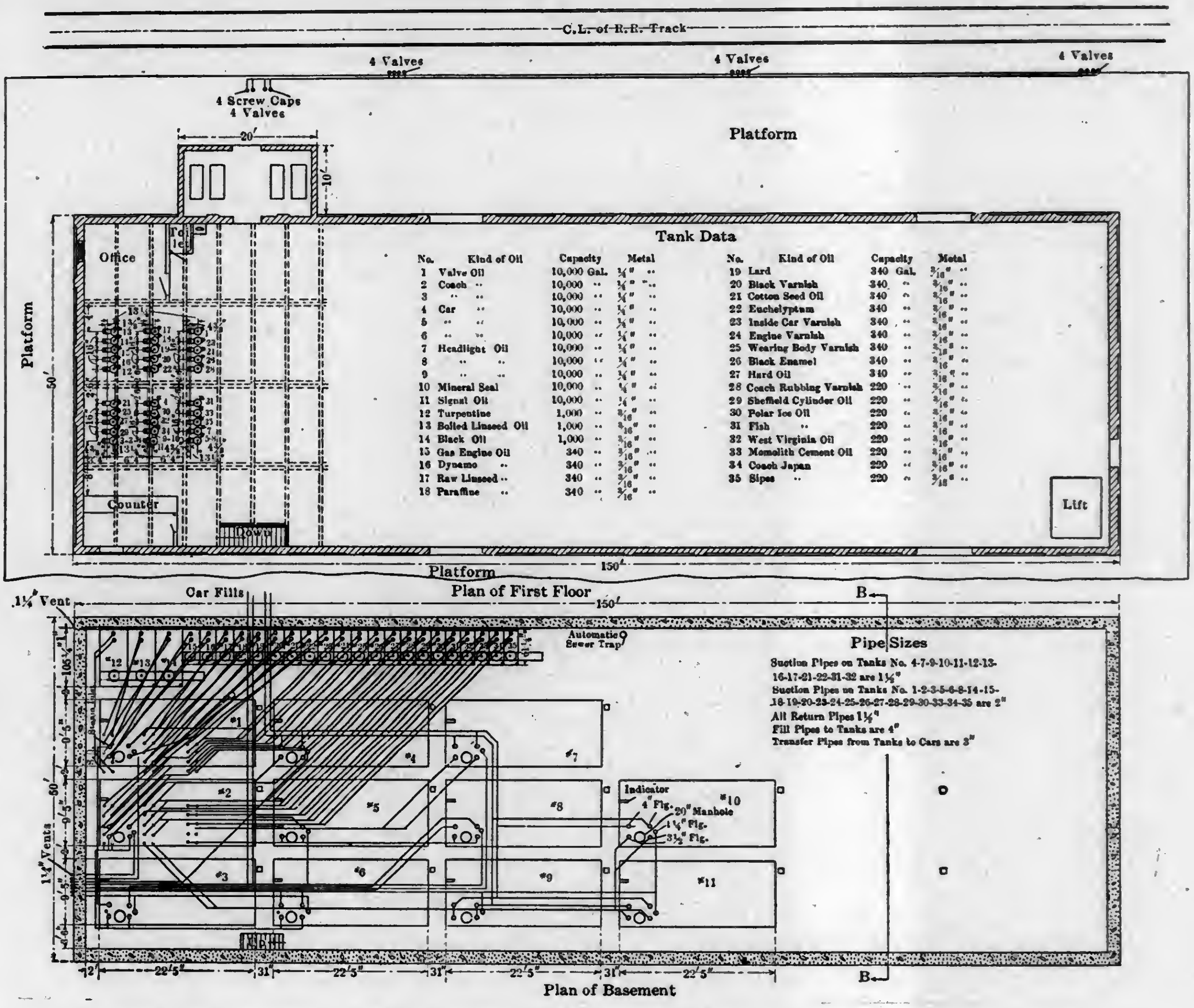
noticed. The construction represents the most advanced ideas in plants of this description, both in material employed and in the general plan. Despite its very large area, 50 by 150 ft., for the building proper, it will be noted from the plans herewith that the most ample provision has been made for the future. The basement contains sufficient unused space for seven additional tanks of 10,000 gallons capacity each, and for some 35 tanks of 340 gallons each, should they be required. As at present constituted, however, the plant is fully adequate to take care of the entire Santa Fe's system needs for the present.

It will be noted that the building is of absolutely fireproof construction throughout. The basement is concrete and the main floor reinforced concrete. A covered platform extends


MAIN OR RETAIL DISTRIBUTING FLOOR.

along the entire one side of the building, adjacent to the railroad track, and under this platform the car fills are arranged, connecting by direct line of piping with their respective tanks. It is said that 300,000 gallons can be transferred in ten hours through the practically faultless system which is employed.

The equipment, which was furnished complete by S. F. Bowser Co., Fort Wayne, Ind., consists of 32 rectangular oil storage tanks made of heavy black soft steel of capacities ranging from 220 to 10,000 U. S. gallons. Each tank is dust proof, and the general arrangement places them low enough to permit of emptying the oil into them through gravity if required. They are equipped with all necessary flanges for filling, suction, return, and with vent pipes, also with a large manhole to permit ready access for inside inspection or cleaning. The plan employed to vent the tank is specially interesting. These are automatic in action, allowing air to escape or be drawn in when filling or emptying, and those used for volatile oils have a special vent



Tank Data

No.	Kind of Oil	Capacity	Metal
1	Valve Oil	10,000 Gal.	¼" "
2	Coach "	10,000 "	¼" "
3	" "	10,000 "	¼" "
4	Car "	10,000 "	¼" "
5	" "	10,000 "	¼" "
6	" "	10,000 "	¼" "
7	Headlight Oil	10,000 "	¼" "
8	" "	10,000 "	¼" "
9	" "	10,000 "	¼" "
10	Mineral Seal	10,000 "	¼" "
11	Signal Oil	10,000 "	¼" "
12	Turpentine	1,000 "	3/16" "
13	Boiled Linseed Oil	1,000 "	3/16" "
14	Black Oil	1,000 "	3/16" "
15	Gas Engine Oil	340 "	3/16" "
16	Dynamo "	340 "	3/16" "
17	Raw Linseed "	340 "	3/16" "
18	Paraffine "	340 "	3/16" "
19	Lard	340 Gal.	3/16" "
20	Black Varnish	340 "	3/16" "
21	Cotton Seed Oil	340 "	3/16" "
22	Euchelyptum	340 "	3/16" "
23	Inside Car Varnish	340 "	3/16" "
24	Engine Varnish	340 "	3/16" "
25	Wearing Body Varnish	340 "	3/16" "
26	Black Enamel	340 "	3/16" "
27	Hard Oil	340 "	3/16" "
28	Coach Rubbing Varnish	220 "	3/16" "
29	Sheffield Cylinder Oil	220 "	3/16" "
30	Polar Ice Oil	220 "	3/16" "
31	Fish "	220 "	3/16" "
32	West Virginia Oil	220 "	3/16" "
33	Momolith Cement Oil	220 "	3/16" "
34	Coach Japan	220 "	3/16" "
35	Sipes "	220 "	3/16" "

FLOOR PLANS OF THE NEW SANTA FE OIL HOUSE AT TOPEKA, KANS., SHOWING ARRANGEMENT OF OIL TANKS AND PIPING.

pipe run to the outside of the building, and at a sufficient height to insure against evaporation. This will permit gases to escape in the event of excessive heat, thus removing all possibility of explosion.

Provision is made for filling the largest tanks directly from the tank cars. The contents of each tank can always be determined at once by the system of gallonage indicators. These are metal faced, one for each tank with suitable mountings, and are secured to the storeroom wall over the basement where the tanks are located, and connected with the floats in the respective tanks by pullies and flexible cords. This convenient arrangement enables those in charge to keep a close account of the contents of the tanks without the necessity of entering the basement. Each of the tanks is white enameled, giving them a very neat and clean appearance.

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As has been mentioned, this rapid transfer of oil from car to car is a point of much importance in connection with the Santa Fe's oil distribution system. This is not only to release the car promptly, but to start its own car as promptly on its way to the distant point where the oil may be required.

At these outlying points, or outside terminals, the Santa Fe has what is known as the combination oil and storehouse. It has discontinued building the old style oil houses separate and distinct from the storehouse. Instead, a concrete basement is built under the storehouse platform, ranging from 20 to 100 ft. away, connected up with the Bowser long distance self-measuring pumps and with the pumps placed in the end of the storehouse, so that the man issuing the material and supplies can take care of the oil department as well. By this arrangement the first cost of the oil house is eliminated and the reduced cost of handling by reason of the combination does away with the special men that would be employed to take care of the oil house. The saving is from $90 to $100 per month in this regard.

The storage tanks at each outlying station are in capacity based on the station issues, and the stock is replenished monthly from the supply car which is equipped with a hose connection allowing the storage tank to be filled in two or three minutes. The Bowser system is used at all points on the Santa Fe and since their installation a slight overage has been shown for each of the different grades of oil. Prior to that time at the end of each year there was a shortage of from one to three per cent.

The General Oil House of the Santa Fe

THE LARGEST INSTALLATION YET TO BE MADE IN THIS COUNTRY HAS RECENTLY BEEN COMPLETED AT TOPEKA, KANS., ON THE ATCHISON, TOPEKA & SANTA FE RAILWAY. SELF MEASURING OIL PUMPS CAPABLE OF TRANSFERRING 300,000 GALLONS IN TEN HOURS PROVIDE SUFFICIENT CAPACITY TO TAKE CARE OF OIL DISTRIBUTION FOR THE ENTIRE RAILROAD SYSTEM.

In the general betterment of existing shop facilities, which has been such a prominent feature in connection with railroad operation during the past few years, the very necessary adjuncts, oil storage and distributing plants, have not by any means been neglected. Although the development of these structures has probably not progressed with the rapidity so characteristic of machine and erecting shop, or even roundhouse rehabilitation, still much has been accomplished by designers, and many installations have been made which well illustrate the importance now associated with this particular feature.

One of the most elaborate of recent designs is that of the general oil storage house of the Atchison, Topeka and Santa Fe Railway, which has recently been completed in connection with that company's principal store and shops at Topeka, Kans. As these latter are regarded as system shops, the oil house is also so designated. It constitutes the depot for distribution of lubricating and illuminating oil to all parts of the railroad, and in its size and the completeness of its detail it becomes at once the finest equipped building of the kind as well as the largest ever constructed in this country, if not in the world. The storage capacity reaches the enormous total of 150,000 gallons, this including paints and such oils as raw and boiled linseed, turpentine, etc.

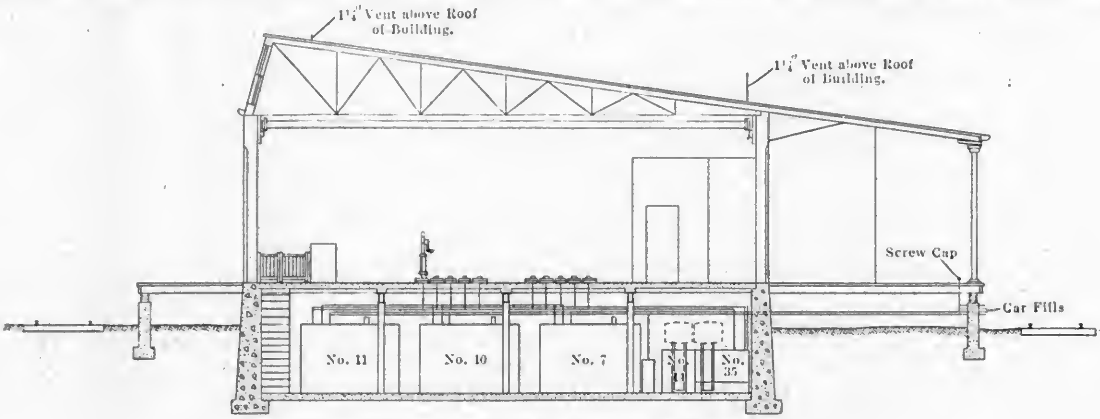
With this new improved oil house and storage plant the Santa Fe is enabled to transfer oil from foreign line cars to its own at Topeka, thereby cutting out the mileage and per diem charges on foreign cars. Under the old system the cars were sent to the farthest point on the line, Richmond, Cal., or south to El Paso and Galveston, and by the time the car returned home the road had from $25 to $35 charges covering it. The extra expense has been entirely eliminated, and in connection with the new plant the Santa Fe has now 35 cars of its own in service for the handling of headlight, mineral, seal, signal, engine, car and valve oil.

Before discussing the installation of the building, which is of particular interest in view of its magnitude, and the exceedingly clever arrangement embodied, several prominent features in connection with the structure itself should not be passed unnoticed. The construction represents the most advanced ideas in plants of this description, both in material employed and in the general plan. Despite its very large area, 50 by 150 ft., for the building proper, it will be noted from the plans herewith that the most ample provision has been made for the future. The basement contains sufficient unused space for seven additional tanks of 10,000 gallons capacity each, and for some 35 tanks of 340 gallons each, should they be required. As at present constituted, however, the plant is fully adequate to take care of the entire Santa Fe's system needs for the present.

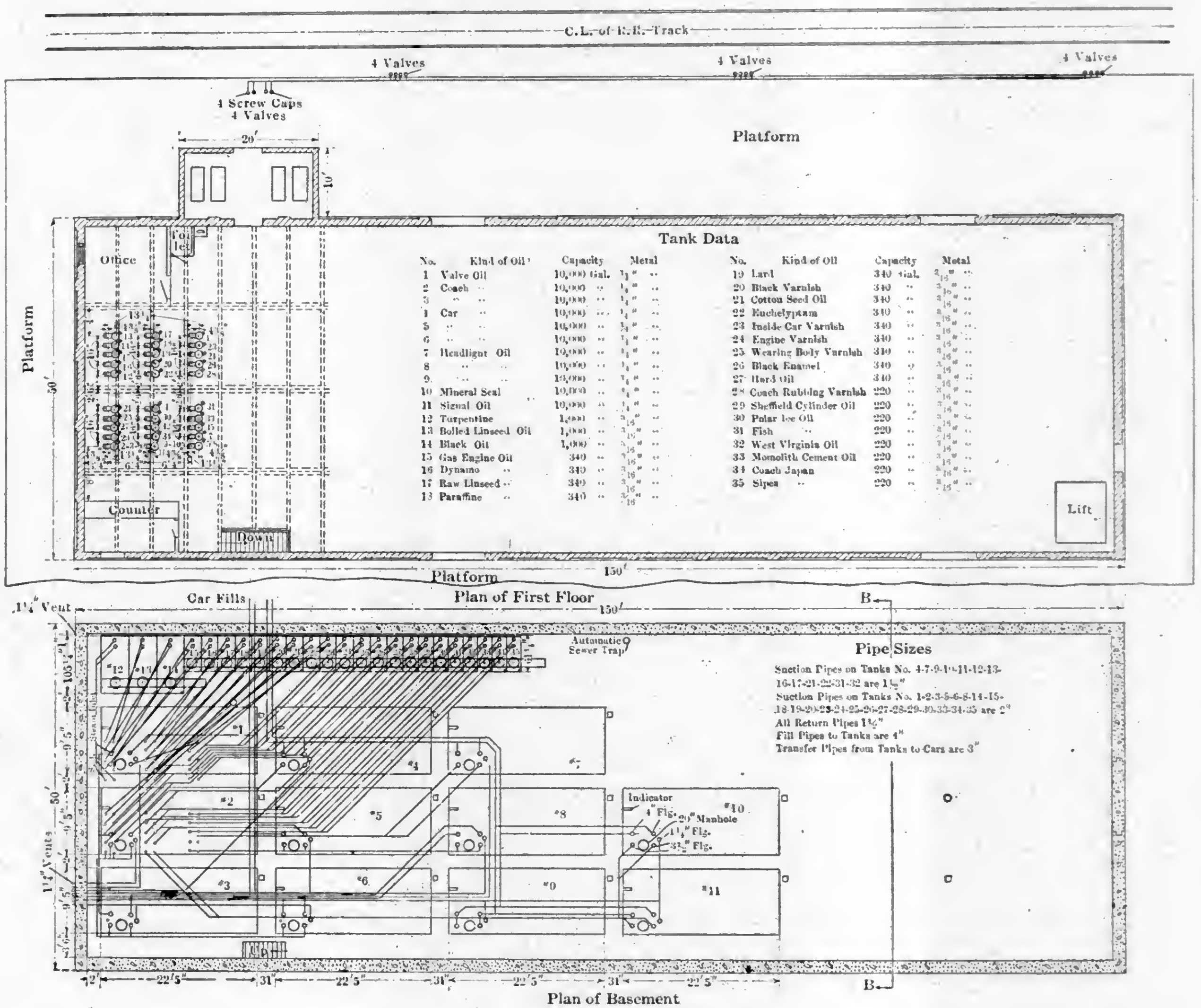
It will be noted that the building is of absolutely fireproof construction throughout. The basement is concrete and the main floor reinforced concrete. A covered platform extends along the entire one side of the building, adjacent to the railroad track, and under this platform the car fills are arranged, connecting by direct line of piping with their respective tanks. It is said that 300,000 gallons can be transferred in ten hours through the practically faultless system which is employed.

MAIN OR RETAIL DISTRIBUTING FLOOR.

The equipment, which was furnished complete by S. F. Bowser Co., Fort Wayne, Ind., consists of 32 rectangular oil storage tanks made of heavy black soft steel of capacities ranging from 220 to 10,000 U. S. gallons. Each tank is dust proof, and the general arrangement places them low enough to permit of emptying the oil into them through gravity if required. They are equipped with all necessary flanges for filling, suction, return and with vent pipes, also with a large manhole to permit ready access for inside inspection or cleaning. The plan employed to vent the tank is specially interesting. These are automatic in action, allowing air to escape or be drawn in when filling or emptying, and those used for volatile oils have a special vent



ELEVATION ON PLAN LINE B-B.



Tank Data

No.	Kind of Oil	Capacity	Metal	No.	Kind of Oil	Capacity	Metal
1	Valve Oil	10,000 Gal.	1/4″ "	19	Lard	340 Gal.	3/16″ "
2	Coach "	10,000 "	1/4″ "	20	Black Varnish	340 "	3/16″ "
3	" "	10,000 "	1/4″ "	21	Cotton Seed Oil	340 "	3/16″ "
4	Car "	10,000 "	1/4″ "	22	Euchelyptam	340 "	3/16″ "
5	" "	10,000 "	1/4″ "	23	Inside Car Varnish	340 "	3/16″ "
6	" "	10,000 "	1/4″ "	24	Engine Varnish	340 "	3/16″ "
7	Headlight Oil	10,000 "	1/4″ "	25	Wearing Body Varnish	340 "	3/16″ "
8	" "	10,000 "	1/4″ "	26	Black Enamel	340 "	3/16″ "
9	" "	10,000 "	1/4″ "	27	Hard Oil	340 "	3/16″ "
10	Mineral Seal	10,000 "	1/4″ "	28	Coach Rubbing Varnish	220 "	3/16″ "
11	Signal Oil	10,000 "	1/4″ "	29	Sheffield Cylinder Oil	220 "	3/16″ "
12	Turpentine	1,000 "	3/16″ "	30	Polar Ice Oil	220 "	3/16″ "
13	Boiled Linseed Oil	1,000 "	3/16″ "	31	Fish "	220 "	3/16″ "
14	Black Oil	1,000 "	3/16″ "	32	West Virginia Oil	220 "	3/16″ "
15	Gas Engine Oil	340 "	3/16″ "	33	Monolith Cement Oil	220 "	3/16″ "
16	Dynamo "	340 "	3/16″ "	34	Coach Japan	220 "	3/16″ "
17	Raw Linseed "	340 "	3/16″ "	35	Sipes "	220 "	3/16″ "
18	Paraffine "	340 "	3/16″ "				

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NAVAL STATISTICS

Some very interesting information has been issued by the Naval Department in connection with the equipment and personnel of the larger navies of the world. This information bears the date of December 1, and was accurate at that time.

In respect to tonnage of war vessels in the various navies, data is given for both the navies as they exist at present and as they will be when vessels now actually under construction are finished. The latter is headed "future tonnage" in the following table:

	Present Tonnage.	Future Tonnage.
Great Britain	1,859,168	2,173,838
United States	717,702	824,152
Germany	666,035	963,845
France	556,306	725,231
Japan	413,291	493,671
Russia	289,113	401,463
Italy	219,959	327,059

From this it will be seen that although the United States now holds second place in total tonnage, it will be passed by Germany when ships now under construction are completed. This is due to the fact that Germany is building nine of the largest sized battleships to the United States four, and she is also building three of the largest size armored cruisers, four small cruisers and a large number of torpedo boats and submarines, while our navy is building only torpedo boat destroyers and submarines.

An investigation of the personnel information furnished by these bulletins is very interesting. In the following table is given the ratio of number of enlisted men and also of ship tonnage to one commissioned officer, which includes warranted officers, in the five principal navies:

	Enlisted Men.	Tons.
Great Britain	15.1	215
United States	19.2	226
France	10	108
Germany	10.2	118
Japan	10.4	93

This table very clearly indicates how seriously unofficered the U. S. navy is as compared with other navies, its ratio in this respect being about 25 per cent. less than Great Britain and 100 per cent. less than France, Germany and Japan, as regards enlisted men.

The number of enlisted men, including marines, as compared to the total tonnage of the various navies, is given in the following table, there being one enlisted man to the tonnage given:

	Tons.
Great Britain	15.3
United States	12.6
France	10.8
Germany	12.7
Japan	9.9

This table shows that England, although having a much greater proportion of officers, requires fewer enlisted men for the same tonnage, and that Germany and the U. S. are about on a par as regards enlisted strength, but Germany has about twice as many officers as the U. S. for the same number of men. Japan and France apparently seem to be overmanned.

The tables from which this information has been collected can be obtained by request to the office of Naval Intelligence, Navy Department, Washington, D. C.

RAILWAY ACCIDENTS IN 1910.—The report of the Interstate Commerce Commission shows that during the fiscal year of 1910, 227 passengers were killed, as compared with 131 for the previous year. There also was an increase in the number of employees killed and injured. The Commission says that it has not yet undertaken to make a careful investigation of railroad accidents because there is no appropriation adequate to provide for the employment of a sufficient number of men of sufficient character and ability to conduct the inquiries. It is noted that a marked improvement has been made in the practices of railroads throughout the country in guarding against violations of the safety appliance laws.

THE RAILWAYS IN ARGENTINE will standardize their freight car couplings and replace all the old devices at present in use. This will cost about $2,500,000, it is said.

SOLID STEEL WHEELS

J. C. NEALE.

The steel wheel is as logical a successor to the cast iron wheel as steel rails and ties are to the old iron and wooden construction. The heavy loads which freight cars are now built to carry demand a substitute for cast iron wheels, and as this is distinctly a "Steel Age," the natural thing to do was to look to this material, which possesses all the necessary attributes, to meet the situation.

That there is a limit to the utility of cast iron wheels was the realization which came with the more powerful locomotives, and consequently heavier tenders which became necessary to haul the gradually increasing train loads. The demand for a stronger wheel was first met in this class of service by the steel tired wheel, and as the demands upon wheels in other classes of service have increased, the field of the steel tired wheel has broadened until it is now common under passenger train cars as well. It has never become common, however, under freight equipment on account of its extremely high cost. The absolute necessity of finding a wheel for freight service with the strength and wearing qualities of a steel tired wheel, but at the same time less expensive, is, therefore, the real reason for the existence of solid steel wheels to-day. Now that the solid wheel is here, it is gaining a place not only under freight cars, but in all exacting classes of service.

The only possible objection to the substitution of the steel wheel for cast iron in freight service is its initial cost, which is perhaps three to five times that of a cast iron wheel, but in these modern days of exact accounting and careful investigation of costs over a sufficiently long period to demonstrate ultimate value, even this objection is sure to be either altogether removed or very greatly discounted. Furthermore, in weighing the cost of cast iron wheels against that of steel wheels, the item of loss resulting from wrecks due to broken flanges should not be lost sight of. It is an indeterminate quantity, but a very real and important one, nevertheless. There are, of course, conditions under which cast iron wheels meet all requirements, and it is doubtful if they will ever be displaced by any other kind of wheel. Regarding such cases there is no argument.

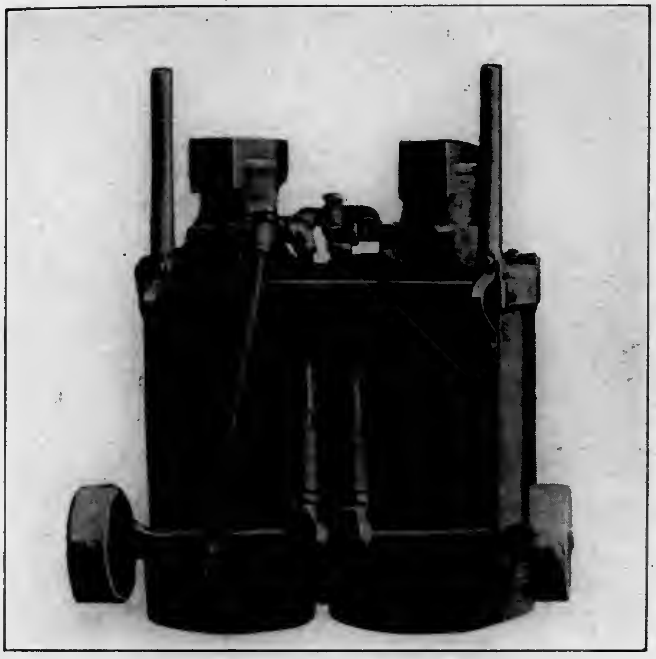
The only thing which stands in the way of the universal adoption of solid steel wheels for the more exacting classes of service is, therefore, the steel tired wheel. The solid wheel, being a more recent product, will have to overcome the prejudice in favor of its earlier steel tired rival, but the application of common sense reasoning on the part of operating officials must eventually overcome this prejudice as its advantages are certainly most obvious. The argument of first cost is not applicable here, because a complete steel tired wheel is more expensive than a solid wheel. However, the cost of re-tiring the original center has also to be taken into account when the cost of substituting solid wheels is being considered.

It is the belief of the writer that in respect to cost neither type of wheel has any great advantage over the other in the long run, and, therefore, the contest between the two wheels will be fought out upon the question of which is the safer and consequently causes less worry to the mechanical officials. In this respect the solid wheel has the advantage, because it is one solid piece of steel and has no component parts subject to the liability of becoming loosened with the consequent danger of failure. If the tire of a steel tired wheel is merely shrunk on its cast iron or cast steel center, its gripping power decreases as the metal wears away, because the thinner the tire, the more easily it is heated by its friction against the rail and the greater the tendency for it to expand and leave the solid center. If the tire is fastened to the center by means of bolts or retaining rings, these are apt to become loose by constant jarring and thus allow the tire itself to become loose. The verdict, therefore, seems to be in favor of the solid wheel. It may require a good many years for the solid steel wheel to obtain full recognition of its merits, but there does not appear any question about its final and complete triumph.

EFFICIENT TWIN AIR JACK FOR CAR REPAIRS

NEW YORK, NEW HAVEN & HARTFORD R. R.

The rapid increase in the weight of passenger car bodies during recent years has brought with it certain problems in connection with features of repair work, not the least important of which is the prompt and satisfactory handling of the car body in the event of jobs which necessitate the removal of a truck.

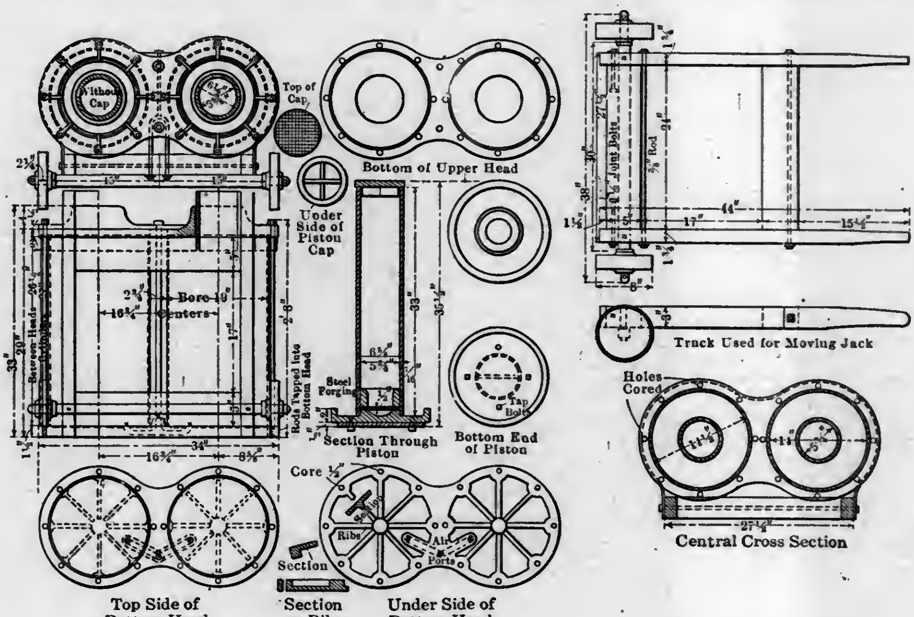


DOUBLE JACK FOR HEAVY CAR WORK.

On a great many roads the familiar operation of elevating the car through the means of hydraulic jacks is still in vogue despite the tediousness of the operation, and the undisputed element of danger which is associated with it. With car bodies, however, which have in some instances reached 100,000 lbs. weight, other and more certain devices must be employed, therefore in the more progressive repair yards air jacks have been substituted, and many ingenious special appliances have been worked out to secure the ends desired.

A very interesting example of a powerful twin air jack is shown in the accompanying drawing and illustrations. This jack was designed at the South Boston passenger car inspection yards of the New York, New Haven and Hartford Railroad, and is standard on that system for all truck work and wheel renewal operations wherever access can be had to a compressed air line. The detailed drawing clearly indicates the arrangement of the jack and carrying truck, but the most important feature is the air control arrangement which permits the jack on either side of the car to be operated simultaneously by one man. This is secured by air hose connection from the controlling jack to the other, and the operation is simply effected through an admission and an exhaust cock.

This useful appliance has resulted in some rapid wheel changing on this road in connection with the heaviest equipment and most complicated six-wheel trucks. The work is further facilitated by the presence of a four-track air hoist for raising the truck frame clear of the pedestals after being rolled from under the car. The jacks were built at the Readville shops of the company and have proved most economical as well as efficient, not a cent having been spent on them for repairs since being placed in service. The twin arrangement in connection with each jack secures double lifting power in a form scarcely less compact than in the instance of a single jack to which a permanent truck for rolling is attached.



DETAILS OF THE NEW HAVEN TWIN AIR JACK.

PENNSYLVANIA'S TERMINAL IMPROVEMENTS AT PHILADELPHIA.—Definite steps have been taken by the Pennsylvania Railroad towards a greater Broad Street Station at Philadelphia. A board of engineers was appointed who are to devote their entire time to the assembling of all plans so far suggested, and to present or suggest any new and heretofore unconsidered plans. The result of their work is in turn to be submitted to an advisory board consisting of high officials of the company, and in conjunction with them they are to make a final selection of the plans for the new station to be adopted. The preliminaries will certainly require several months, and until the final report is approved by the board of directors, there will be no work done, beyond that which is now under way. Of course no estimate of the cost can be even approximated until the final acceptance of the plans by the executive of the company, and all reports as to the proposed expenditures are premature and unwarranted.

4-6-2 Locomotive for Chicago and Northwestern R. R.

THESE LOCOMOTIVES, WHICH ARE EQUIPPED WITH THE SCHMIDT SUPERHEATERS, SINCE THEIR RECENT DELIVERY HAVE BEEN MAKING EXCELLENT RECORDS IN SPEED AND ECONOMY ON REGULAR RUNS OF 207 MILES.

In July of last year the Chicago and Northwestern Railroad received an order of 20 Pacific type locomotives from the American Locomotive Co. In design these engines are practically duplicates of a previous order of 25 of the same type which have been described and illustrated in this journal,* except that 5 of the present order, one of which is shown in the accompanying illustration, are equipped with the Locomotive Superheater Co.'s† top header, double loop design of superheater. The officials of the Chicago and Northwestern report that since they have been

PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

in service the performance of the superheater engines has been very satisfactory, showing considerable saving in coal and water as compared with locomotives of the same class using saturated steam.

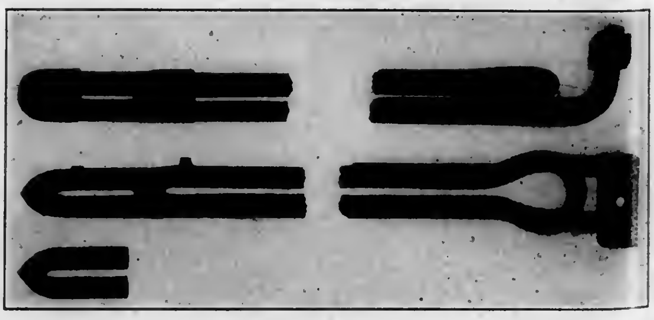
Up to within a comparatively recent period this road employed the Atlantic type for fast, and the 4-6-0 for the heavier trains, but the increase in weight of trains generally necessitated the adoption of the 4-6-2 type. The first, and the non-superheat, of this class after being under observation for about a year demonstrated the correctness of the design, and with the exception of changes made necessary by the installation of the superheater no modifications whatever were made. The locomotives using saturated steam are equipped with cylinders 23 by 28 in., while the cylinders of the superheater engines are 25 in. in diameter, and 28 in. stroke. Both classes of engines are designed for a working pressure of 190 lbs., but it is understood that the superheater engines are actually being run with a working pressure of 175 lbs. The records show that the superheater engines burn about one ton less coal per 100 miles than the saturated steam engines, saving about 4 tons of coal on a round trip.

At present these engines are making through runs from Chicago to Elroy, a distance of 207 miles. Although the schedules are not particularly severe, they are, nevertheless, such that the saturated steam locomotives barely make them, or, at least, are not able to make up more than 10 or 12 minutes on the run. Going south over this division these latter engines always take coal at Evansville, while the engines here illustrated very seldom find it necessary to do so. Because of the saving of water consumption effected by the use of superheated steam it is necessary for these engines to take water only where the trains make regular stop. As a regular thing they run 113 miles for water, which will be recognized as a most unusual performance with trains of such weight, even admitting the 8,275 gallons capacity of the tank. It is also quite an important feature on the division referred to as it cuts out one regular stop.

It is said that in two months one of the engineers running these engines never pulled into Elroy late. In one instance his train was 35 minutes late at Madison, and arrived at Elroy on time, making up the 35 minutes in 76 miles. This performance is more interesting in view of the fact that on this particular section the saturated steam engines are never able to make up any time. On the line from Chicago to Milwaukee, 85 miles, the records show that superheater engines save a ton of coal each way.

The application of the superheater is clearly shown in the line drawing. It is known as "Type A," and embodies many interesting details of construction. In this type the upper part of the boiler is fitted with four rows of large smoke tubes. These tubes are of weldless drawn steel about 5 in. diameter, except near their fire box ends where the diameter is somewhat reduced, and inserted in each is a superheater element or section, consisting of two sets of pipes bent in the form of a U and connected at the smoke box and to a header, thus forming a continuous double looped tube. The steam has to traverse each element to and fro.

The superheater elements are made of seamless steel tubes of about 1½ in. O. D. The connection between the tubes on the firebox side are either made by U bends of cast steel, or by welding. The illustration herewith shows both methods. In the first instance the superheater tubes are received into the U bends with a taper ¾ in. in 12 in., and 12 threads to the inch, and the return bend counterbored about ¼ in. deep in order to protect the end of the thread. The open ends of each element extend into the smokebox where they are bent upwards and expanded into a

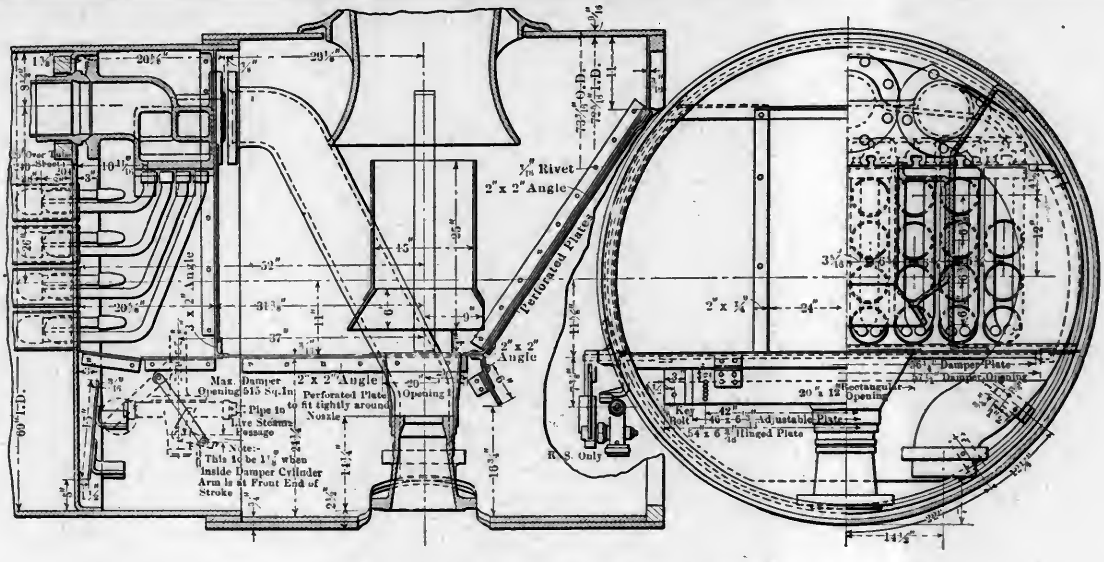


SUPERHEATER TUBES.

common flange, which is secured to the face of the steam collector by a single central bolt. Superheater flanges and steam collector are both machined for the superheater gaskets. The construction of the steam collector, and its connections to the steam pipes and steam chests are such that the steam has to pass through all the superheater tubes simultaneously on its way from the boiler to the cylinders.

The main features of this type lie in its thorough interchangeability and accessibility. Each individual superheat element can be removed and examined without disconnecting the whole ar-

* See AMERICAN ENGINEER, July, 1910, page 259.
† 30 Church street, New York, N. Y.



APPLICATION OF SUPERHEATER TO C. & N. W. PACIFIC TYPE LOCOMOTIVE.

rangement, by merely loosening the single nut securing it in position. At the same time the flue tubes are rendered thoroughly accessible for cleaning and inspection.

In its application to this locomotive the superheater is designed to give an average temperature of 600 degrees F. The rear bend is only 24 in. from the back flue sheet which is somewhat nearer than has heretofore been customary in American locomotive practice, but which tends to give a higher degree of superheat. A heating surface of 691 sq. ft. is provided, which is 21 per cent. of the total evaporating heating surface and about 23 per cent. of the evaporating tube heating surface. Extended piston rod and valve rods are employed, thereby reducing the friction on these parts and making their proper lubrication easier. In both the saturated and superheater steam engines, steam is distributed to the cylinders by 14 piston valves, actuated by a simple design of the Walschaert valve gear.

A result of the satisfactory service of the engines here illustrated, superheaters of the same type were specified for 30 out of an order of 50 consolidation engines now being delivered by the American Locomotive Co.

The general dimensions of the new superheater Pacifics is as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Bit. coal
Tractive effort	37,700 lbs.
Weight in working order	250,500 lbs.
Weight on drivers	154,500 lbs.
Weight on leading truck	51,000 lbs.
Weight on trailing truck	45,000 lbs.
Weight of engine and tender in working order	408,400 lbs.
Wheel base, driving	13 ft. 6 in.
Wheel base, total	34 ft. 7 in.
Wheel base, engine and tender	66 ft. 10½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.09
Total weight ÷ tractive effort	6.64
Tractive effort × diam. drivers ÷ heating surface	846.90
Total heating surface ÷ grate area	63.15
Firebox heating surface ÷ total heating surface, %	6.28
Weight on drivers ÷ total heating surface	46.12
Total weight ÷ total heating surface	75.27
Volume both cylinders, cu. ft	15.90
Total heating surface ÷ vol. cylinders	209.30
Grate area ÷ vol. cylinders	3.30

CYLINDERS.

Kind	Simple
Diameter and stroke	25 x 28 in.

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Outside lap	1 1/16 in.
Inside clearance	3/16 in.
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	75 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	37¼ in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	49 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Ext. Wagon top
Working pressure	190 lbs.
Outside diameter of first ring	70 5/16 in.
Firebox, length and width	108⅛ x 70¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	212—2 in.
Tubes, length	20 ft.
Heating surface, tubes	3,092 sq. ft.
Heating surface, firebox	209 sq. ft.
Heating surface, total	3,328 sq. ft.
Superheater heating surface	691 sq. ft.
Grate area	52.7 sq. ft.

TENDER.

Wheels, diameter	37¼ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,275 gals.
Coal capacity	12 tons

ROAD TESTS OF BRIQUETS

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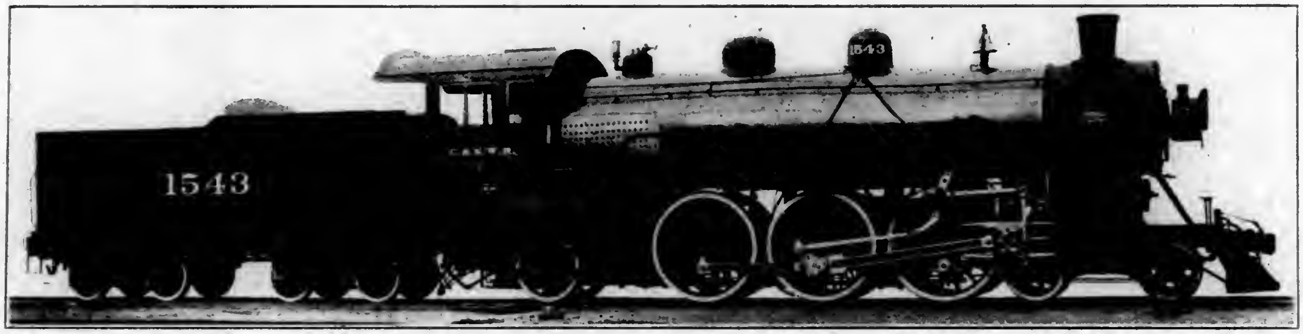
4-6-2 Locomotive for Chicago and Northwestern R. R.

THESE LOCOMOTIVES, WHICH ARE EQUIPPED WITH THE SCHMIDT SUPERHEATERS, SINCE THEIR RECENT DELIVERY HAVE BEEN MAKING EXCELLENT RECORDS IN SPEED AND ECONOMY ON REGULAR RUNS OF 207 MILES.

In July of last year the Chicago and Northwestern Railroad received an order of 20 Pacific type locomotives from the American Locomotive Co. In design these engines are practically duplicates of a previous order of 25 of the same type which have been described and illustrated in this journal,* except that 5 of the present order, one of which is shown in the accompanying illustration, are equipped with the Locomotive Superheater Co.'s† top header, double loop design of superheater. The officials of the Chicago and Northwestern report that since they have been in service the performance of the superheater engines has been very satisfactory, showing considerable saving in coal and water as compared with locomotives of the same class using saturated steam.



PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

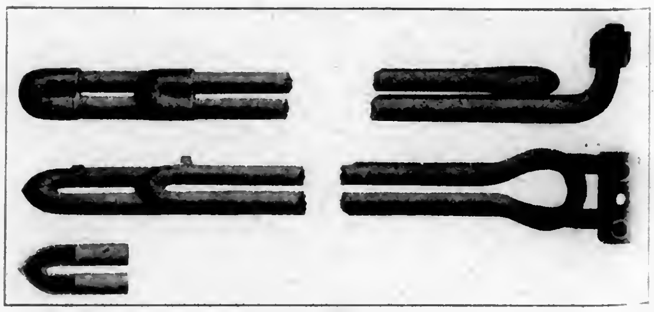
Up to within a comparatively recent period this road employed the Atlantic type for fast, and the 4-6-0 for the heavier trains, but the increase in weight of trains generally necessitated the adoption of the 4-6-2 type. The first, and the non-superheat, of this class after being under observation for about a year demonstrated the correctness of the design, and with the exception of changes made necessary by the installation of the superheater no modifications whatever were made. The locomotives using saturated steam are equipped with cylinders 23 by 28 in., while the cylinders of the superheater engines are 25 in. in diameter, and 28 in. stroke. Both classes of engines are designed for a working pressure of 190 lbs., but it is understood that the superheater engines are actually being run with a working pressure of 175 lbs. The records show that the superheater engines burn about one ton less coal per 100 miles than the saturated steam engines, saving about 4 tons of coal on a round trip.

At present these engines are making through runs from Chicago to Elroy, a distance of 207 miles. Although the schedules are not particularly severe, they are, nevertheless, such that the saturated steam locomotives barely make them, or, at least, are not able to make up more than 10 or 12 minutes on the run. Going south over this division these latter engines always take coal at Evansville, while the engines here illustrated very seldom find it necessary to do so. Because of the saving of water consumption effected by the use of superheated steam it is necessary for these engines to take water only where the trains make regular stop. As a regular thing they run 113 miles for water, which will be recognized as a most unusual performance with trains of such weight, even admitting the 8,275 gallons capacity of the tank. It is also quite an important feature on the division referred to as it cuts out one regular stop.

It is said that in two months one of the engineers running these engines never pulled into Elroy late. In one instance his train was 35 minutes late at Madison, and arrived at Elroy on time, making up the 35 minutes in 76 miles. This performance is more interesting in view of the fact that on this particular section the saturated steam engines are never able to make up any time. On the line from Chicago to Milwaukee, 85 miles, the records show that superheater engines save a ton of coal each way.

The application of the superheater is clearly shown in the line drawing. It is known as "Type A," and embodies many interesting details of construction. In this type the upper part of the boiler is fitted with four rows of large smoke tubes. These tubes are of weldless drawn steel about 5 in. diameter, except near their fire box ends where the diameter is somewhat reduced, and inserted in each is a superheater element or section, consisting of two sets of pipes bent in the form of a U and connected at the smoke box and to a header, thus forming a continuous double looped tube. The steam has to traverse each element to and fro.

The superheater elements are made of seamless steel tubes of about 1¼ in. O. D. The connection between the tubes on the firebox side are either made by U bends of cast steel, or by welding. The illustration herewith shows both methods. In the first instance the superheater tubes are received into the U bends with a taper ¾ in. in 12 in., and 12 threads to the inch, and the return bend counterbored about ¼ in. deep in order to protect the end of the thread. The open ends of each element extend into the smokebox where they are bent upwards and expanded into a

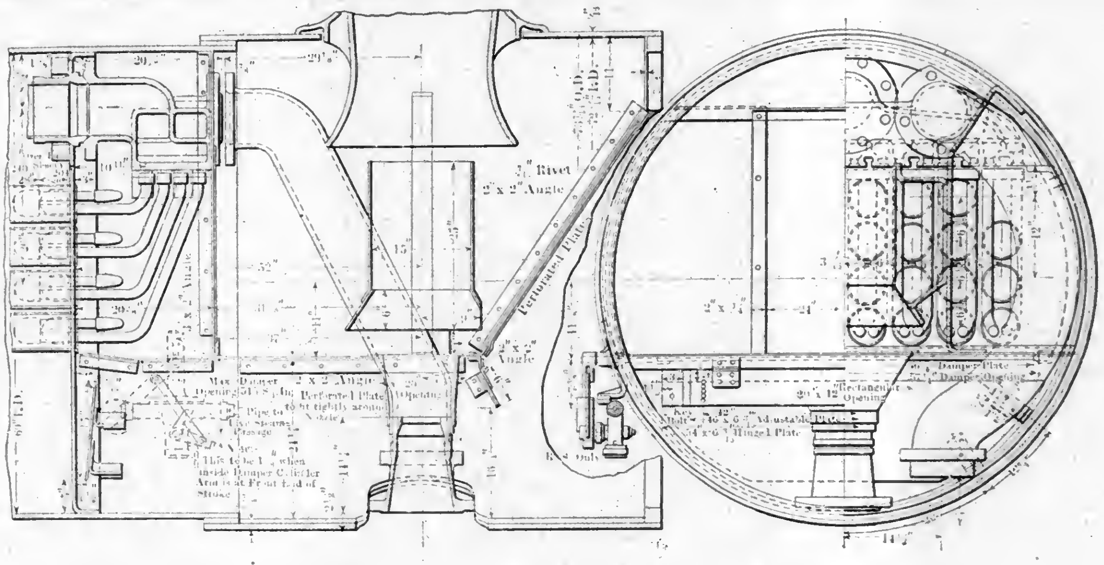


SUPERHEATER TUBES.

common flange, which is secured to the face of the steam collector by a single central bolt. Superheater flanges and steam collector are both machined for the superheater gaskets. The construction of the steam collector, and its connections to the steam pipes and steam chests are such that the steam has to pass through all the superheater tubes simultaneously on its way from the boiler to the cylinders.

The main features of this type lie in its thorough interchangeability and accessibility. Each individual superheat element can be removed and examined without disconnecting the whole ar

* See AMERICAN ENGINEER, July, 1910, page 259.
† 30 Church street, New York, N. Y.



APPLICATION OF SUPERHEATER TO C. & N. W. PACIFIC TYPE LOCOMOTIVE.

rangement, by merely loosening the single nut securing it in position. At the same time the flue tubes are rendered thoroughly accessible for cleaning and inspection.

In its application to this locomotive the superheater is designed to give an average temperature of 600 degrees F. The rear bend is only 24 in. from the back flue sheet which is somewhat nearer than has heretofore been customary in American locomotive practice, but which tends to give a higher degree of superheat. A heating surface of 691 sq. ft. is provided, which is 21 per cent. of the total evaporating heating surface and about 23 per cent. of the evaporating tube heating surface. Extended piston rod and valve rods are employed, thereby reducing the friction on these parts and making their proper lubrication easier. In both the saturated and superheater steam engines, steam is distributed to the cylinders by 14 piston valves, actuated by a simple design of the Walschaert valve gear.

A result of the satisfactory service of the engines here illustrated, superheaters of the same type were specified for 30 out of an order of 50 consolidation engines now being delivered by the American Locomotive Co.

The general dimensions of the new superheater Pacifics is as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Bit. coal
Tractive effort	37,700 lbs.
Weight in working order	250,500 lbs.
Weight on drivers	154,500 lbs.
Weight on leading truck	51,000 lbs.
Weight on trailing truck	45,000 lbs.
Weight of engine and tender in working order	408,400 lbs.
Wheel base, driving	13 ft. 6 in.
Wheel base, total	34 ft. 7 in.
Wheel base, engine and tender	66 ft. 10½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.09
Total weight ÷ tractive effort	6.64
Tractive effort × diam. drivers ÷ heating surface	846.90
Total heating surface ÷ grate area	63.15
Firebox heating surface ÷ total heating surface, %	6.28
Weight on drivers ÷ total heating surface	46.12
Total weight ÷ total heating surface	75.27
Volume both cylinders, cu. ft.	15.90
Total heating surface ÷ vol. cylinders	209.30
Grate area ÷ vol. cylinders	3.30

CYLINDERS.

Kind	Simple
Diameter and stroke	25 x 28 in.

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Outside lap	1 1/16 in.
Inside clearance	3/16 in.
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	75 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	37¼ in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	49 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Ext. Wagon top
Working pressure	190 lbs.
Outside diameter of first ring	70 5/16 in.
Firebox, length and width	108⅛ x 70¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	212—2 in.
Tubes, length	20 ft.
Heating surface, tubes	3,092 sq. ft.
Heating surface, firebox	209 sq. ft.
Heating surface, total	3,328 sq. ft.
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The Wade-Nicholson Arch

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A series of valuable experiments to determine the influence of the Wade-Nicholson arch on the output of locomotive boilers have been completed on the testing plant of the Poutilow locomotive works in Russia, and the results are of decided interest in furnishing reliable data for the general consideration of a question which heretofore has been largely speculative. It has been demonstrated through these tests that the hollow arch is much superior to that of ordinary construction.

The general design of this arch as applied to the 8-wheel freight locomotive of the Russian North Western Railway under test is shown in the accompanying drawing. It consists of two parts; the deflector, fixed above the fire door, and the arch proper, with passages for heating the air entering from the outside through four small inlets, two of 2¾ in. internal diameter for the arch proper, and two of 2¼ in. internal diameter, above the fire door for the deflector. The arch and the deflector are made of refractory bricks of special shape, the deflector consisting of six and the arch of nine bricks, and the air passages are partly in the points which are made with fire clay.

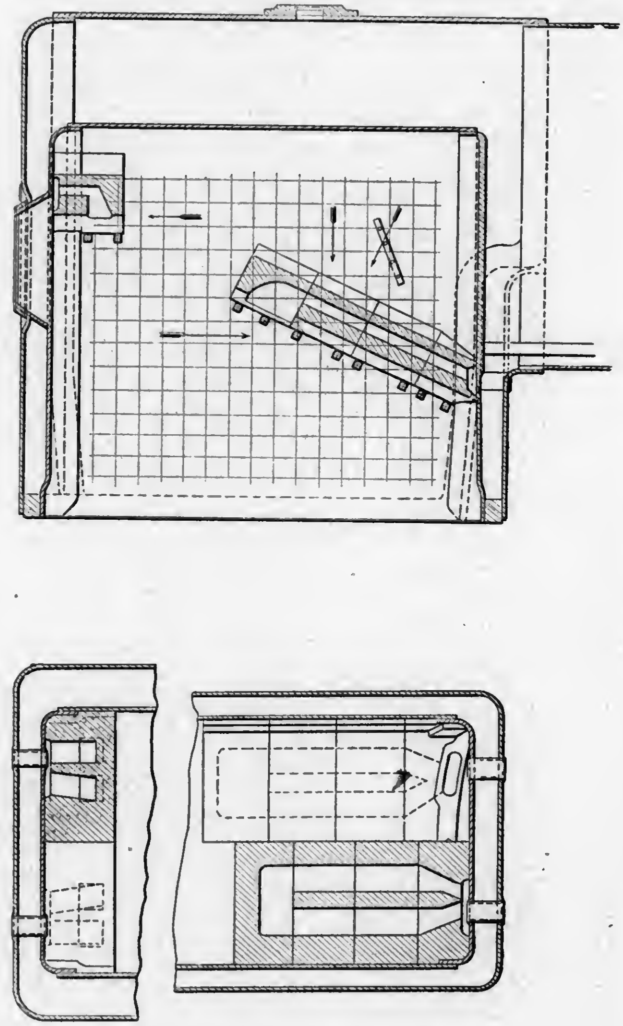
The air arriving through the passages in the fire arch, which is white hot, becomes heated, and leaves in two horizontal jets which meet above the grate, forming a sort of barrier across the firebox, in the space between the arch and the deflector, to the products of combustion. As this air is nevertheless colder than the products of combustion, it descends, in part to the layer of incandescent fuel, but the greater part of the air, meeting the products of combustion which are moving towards the space between the two arches, becomes mixed perfectly with them, becoming still more heated and producing a complete combustion of gases, in the space above the arch, as they pass on their way to the fire tubes.

In this way, while possessing all the qualities of the ordinary arch, the construction is arranged so as to admit an extra amount of hot air, thus increasing the evaporation obtained from the fuel (1) by insuring its more complete combustion, (2) by raising the temperature of combustion, (3) by somewhat reducing the vacuum in the firebox (resulting from the entrance of air through the inlets), and (4) by reducing the quantity of cinders drawn over into the smokebox. The result should be to secure more economic working of the boiler, and an economy in the coal consumed per cent. of energy. It was in order to determine this data that the experiments on the testing plant were conducted, both before and after the arch had been applied.

The trials were carried out in the usual way, the fuel being Yorkshire coal and the mean speed not rising above 5.8 miles per hour. Great care was taken to avoid the risk of overloading the locomotive, which would have made the test of no value.

Proceeding with an examination of the data obtained, it is shown that the quantities of sparks or cinders removed from the smokebox were smaller in the trials with the arch in by 20.4 per cent. on the average. The evaporative power of the coal was increased, by the arch, by from 6.9 to 39.7 per cent., mean 20.9 per cent., if the immediate results of the trials are taken into consideration and the residues left from the coal put into the firebox not deducted. If these latter are allowed for the increase in evaporative power is from 12.9 to 36.6 per cent., average 22.8 per cent. If, in the trials with the arch applied, this correction is made and the amount of residue allowed for, it is found that the increase in evaporative power is from 11.5 to 42.7 per cent., mean 24 per cent., residues not deducted, and from 7.9 to 34.1 per cent., mean 19.5 per cent., if these are allowed for.

The mean temperature of the firebox without the arch was 1,369 degrees F., and with the arch 1,429 degrees F., a difference of 60 degrees F. higher. These temperatures were determined by pyrometer readings, and as regards the real temperature of the firebox it may be assumed to be 720 to 810 degrees F. higher. The mean temperature of the smoke box gases was about the same in both cases, viz., 509 and 495 degrees F., being slightly lower with the arch in place. Putting in the air inlets should have had as a result a certain diminution in the ratio of fire box vacuum to smoke box vacuum. The mean ratio of these vacuum readings was 0.30 in the trials without the arch, and 0.31 in the trials with it. The smallness of the difference is ex-



WADE-NICHOLSON HOLLOW ARCH.

plained by the small cross section of the inlets, amounting altogether to only 19.84 square inches. The diameter of the exhaust pipe was 4 15/16 in.

The coal economy resulting from the application of the arch is shown to vary between 14 and 31.5, mean 19.4 per cent., if the corrected data is taken into consideration and the residues are not deducted. If the latter are allowed for, the saving in the coal is from 9.5 to 27.6 per cent., mean 16.6 per cent. Only in one trial, with a cut-off of 30 per cent., is an excess in consumption observed, amounting to 1.6 per cent. if the corrected data is taken under consideration and the residues are not deducted, and to 6.5 per cent. if the latter are allowed for. The only explanation for this is some accidental circumstance or some

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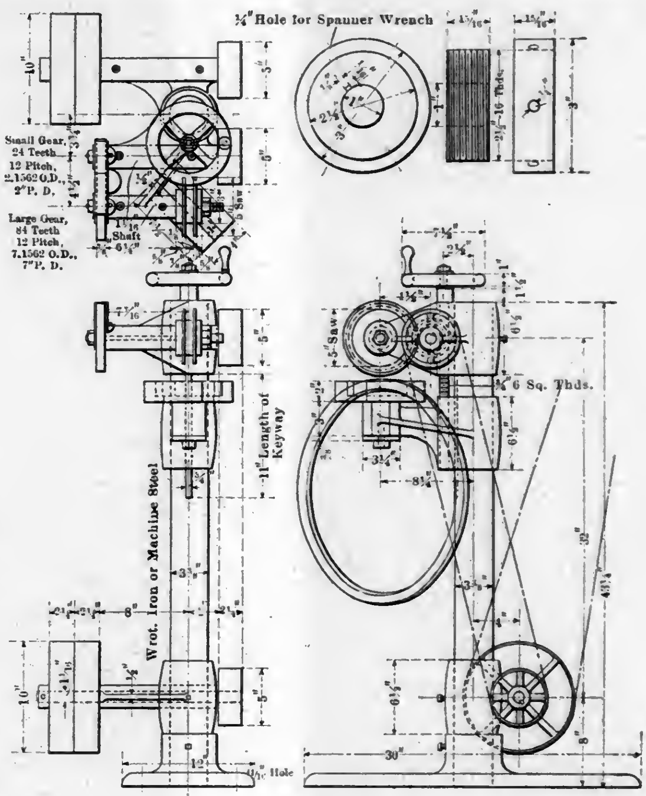
MACHINE FIT PACKING RINGS

CENTRAL OF GEORGIA RY.

The general practice in fitting piston head packing rings to locomotive cylinders is to turn them some ⅜ in. larger than the bore to provide the necessary spring, and cut them on an angle of 45 degrees. It is believed that this method of parting is preferable to the former almost universal plan of grooving the ends of the ring and using a dowel pin in the piston head. It, however, requires considerable fitting to do the job properly. After being cut at the required angle the ring must be sprung into the cylinder, the overlapping end scribed and also cut off at 45 degrees, and with the exercise of care to see that sufficient clearance exists between the two finished ends.

In order to perform the operation in the minimum of time and with the certainty of approximation between the opposing angled ends, the Central of Georgia Ry. has installed in its Macon, Ga., shops a very simple and efficient saw which answers the purpose in every respect for which it was intended. All packing rings are handled by it, and the time, which was from fifteen to thirty minutes when a hack saw was used has been reduced to one minute with the machine. When the rings are cut



ARRANGEMENT OF PACKING RING SAW.

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It will be noted in the accompanying drawing that the arbor is fitted with two 1-16 by 6 in. slitting saws, with an adjustable collet between saws for opening out or closing them to the amount to be cut out. The chuck is made swivel to cut rings on any angle desired, and is raised and lowered by means of the screw and hand-wheel on top of the column, which, however, can be changed to power feed if desired. The chuck has set screws in the back to grip the rings.

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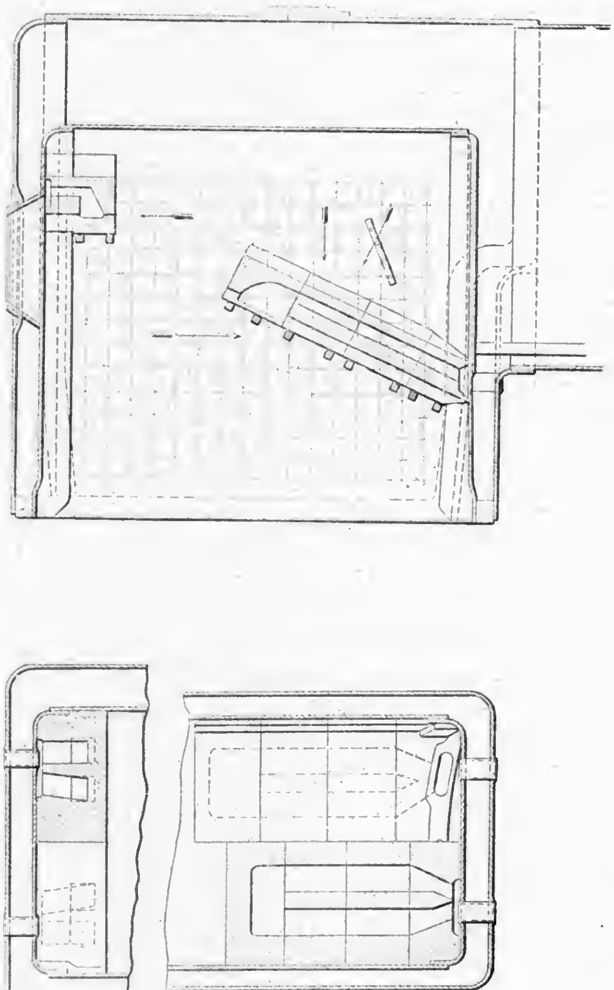

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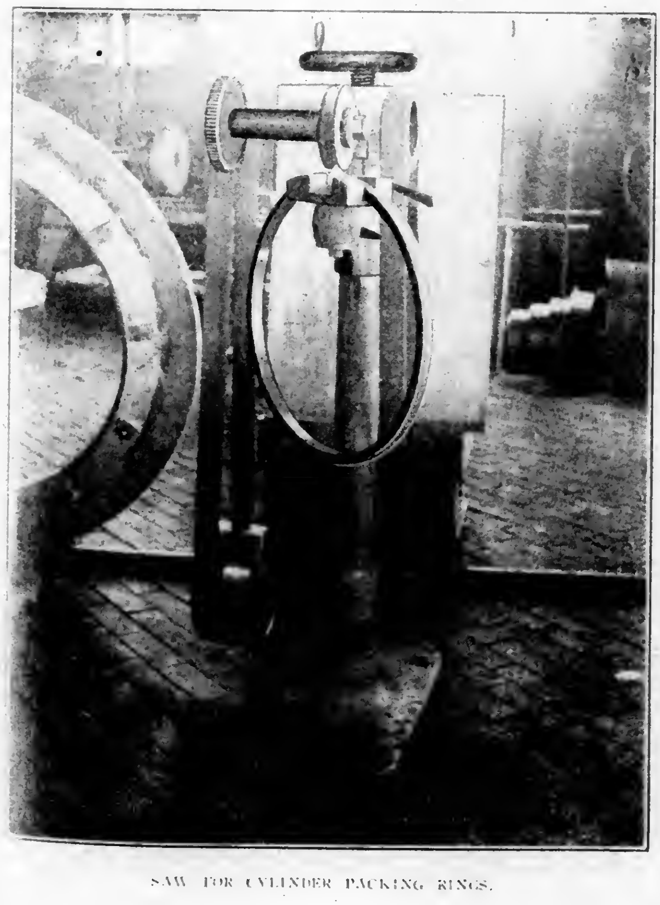

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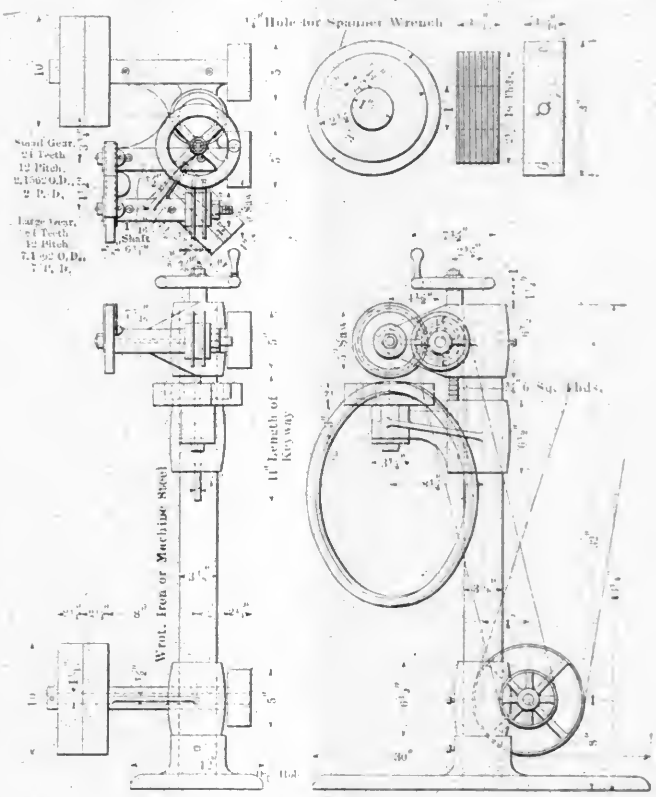

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[ESTABLISHED 1832]
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CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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THE LIGHT UNDER A BUSHEL

It is to be deeply regretted that the discussions which should have followed the presentation of reports to the International Railway Congress during its recent Eighth Session in Berne, Switzerland, were, in the majority of instances, exceedingly limited, and may be said to have practically failed in their recognized object to verify or disprove the views advanced by the various able reporters. In consequence, it is found that the conclusions in many of the reports were given immediate acceptance by the Congress, and without any spirited attempt by the presiding officers of sections to open an argument, or to obtain any dissenting views.

This unfortunate condition was particularly in evidence following the presentation of the papers on water tube boilers, superheaters, and high speed locomotives. These were probably the liveliest subjects before the Congress, and of universal interest, hence it was hoped that through the array of undisputed authorities who were present much valuable information would result from their consideration. It appears, however, that the attitude evinced was to accept these papers without comment, in view probably of the prominence of their authors, and in concession to the mastery which they undoubtedly possess over the subject assigned to them for report.

The reporters were requested not to present their reports in length, and to confine merely to their general conclusions. This arose, no doubt, from the assumption that all reports had received a preliminary reading by the delegates interested in the particular questions, but there is room for considerable doubt in regard to their perusal. This being the case, it became impossible to discuss them intelligently from the conclusions alone, without knowledge of upon what they are based.

It is very unfortunate that the laborious and painstaking work of the eminent reporters to the Congress does not receive at least a reasonable circulation in the railroad world and among those whom it might advantage most. The apathetic attitude of the delegates at the session, however, finds its reflection among the motive power heads of almost every country. A copy of the monthly bulletin of the International Railway Congress seldom leaves the office of the mechanical superintendent, and it is no exaggeration to say that two-thirds of his master mechanics never even saw one.

We said that this was unfortunate because these reports are veritable mines of information. They are prepared by carefully chosen men who know whereof they speak, and are not beyond the comprehension of any one sufficiently intellectual to hold a supervising position. We were impressed by the sterling work of Messrs. Vaughn and Noltein in connection with the general review of the locomotive boiler, and that of Messrs. Garstang and Courtin in the portrayal of high speed locomotives of the world. Months were consumed in the preparation of these reports, and the information embodied therein is invaluable to anyone directly interested in this development.

Nevertheless, we fear that this has been labor to little avail unless it is desired that the reports shall be restricted to the narrow confines of a circulation limited by the office of a department head on one end, and that of the editorial office of a technical publication on the other. It is not believed that such is the intent of the International Railway Congress, but it still remains as a painful truth. Corrective measures are, of course, without the province of the Congress, and they resolve into a problem for solution by the superintendent of motive power on his own road, and dependent upon the importance which he attaches to the matter.

At the present time there is more uniformity in design and in the consideration of certain features of maintenance and operation between the various countries than ever exhibited before, and the necessity for an understanding of what is being done elsewhere under practically the same conditions is becoming more and more of a value which cannot be disputed. It is believed that the free circulation of these invaluable reports will

exert a broadening influence and instill a spirit of tolerance among designers of the different countries where now appears to be largely unfounded criticism, and it is much to be desired that this end may shortly become realized.

TEST OF LOCOMOTIVE FIRE BOXES

In connection with a description of the low water test of the Jacobs-Schupert fire box, which appeared on page 401 of the October, 1910, issue of this journal, it was stated that this test checked the one made a number of years ago by the Pennsylvania Railroad, in showing that there was no danger of explosion by putting cold water on to fire box sheets which had been over-heated. Of course, because of the entire difference in the design and construction of the two fire boxes, this statement meant that this test checked the former one only so far as showing that there was no danger of a sudden cracking or rupture of a fire box sheet heated to a high temperature when cold feed water is injected into the boiler, and also that there was no danger of a sudden very large increase in the steam pressure caused by the hot sheets evaporating the water very rapidly as they were immersed.

Both of these points have been matters of lively discussion at various times and still occasionally are brought up for argument. This test on the Jacobs-Schupert fire box, it would seem, checks the opinions of the best informed engineers on these particular features, although, of course, it must be remembered that the novel construction of this boiler makes it impossible to say that the ordinary fire box would act in the same way, so far as the sheets cracking are concerned, and of course, since this construction employs no staybolts, it is very positive that the stay supported sheet under the same severe treatment would have let go.

The tests mentioned as being made on the Pennsylvania Railroad a number of years ago have been used as a basis of argument on this subject many times, but there seems to be little general knowledge as to the conditions and methods of making them. They were conducted on Oct. 7, 1868, at Kittanning (Horseshoe Curve), near Altoona, with engine No. 99, which was built in March, 1854. This locomotive had a straight boiler, 49 in. in diameter; 25 in. combustion chamber, copper fire box and flues 2½ in. in diameter, and carried a steam pressure of 90 lbs. A steam gauge with a very large dial, visible at a distance, was installed on the locomotive and a steam fire engine, stationed a safe distance away, was connected to the boiler by a 3 in. hose attached to the feed pipe. The engine was fired up and the blower put on, a pressure of 90 lbs. being obtained. The pops were allowed to blow, and the gauge cocks were specially fitted at various levels below the crown sheet and left opened. In about 20 minutes steam came out of the cock located 1 in. below the crown sheet. About half an hour later dry steam issued from the gauge cock 2 in. below the crown sheet. Water was then pumped in by means of the fire engine until the crown sheet was covered. The boiler was then examined and it was found that nothing had given way. The fire was again started and the water level allowed to drop until it was 2 in. below the crown sheet, as shown by the lower gauge cock, and this condition was allowed to continue for 15 minutes, the water level, of course, dropping below this point and the crown sheet becoming very hot. Water was then again pumped in, and it was found that the stay bolts were leaking, and that the crown sheet was slightly bulged, but in other respects no damage had occurred.

It will be seen from these facts that this test, while interesting, has very little value for modern conditions, and is really more of historical than actual importance. Since that time, however, similar tests have been made abroad, in some of which steel fire boxes were used, which conclusively show that up to a point where a stay supported fire box sheet becomes hot enough to lose its strength and permit the stay bolts to pull through the metal there is no danger of a rupture of the sheet, or of an excess pressure on the boiler by pumping in cold water.

THE MAN AND HIS WORK

A recent innovation of the Erie Railroad in placing the name of a trusted engineer on either side of the cab of his locomotive is decidedly a move in the right direction. This man handled the same engine for a very long period; he contributed toward few, if any, engine failures, and he kept the machine out of the shop for a phenomenal period, as such things are measured, before heavy repairs became necessary. The interest which he feels in his locomotive is largely proprietary. He would not accept maybe a better paying run because he could not take it along with him on the new job. Now the company gracefully recognizes his faithfulness and skill by identifying him with his engine and it with him.

We think well of this departure, and are confident that it will bring results in widespread efficiency which will prove most gratifying. It is a very common old world procedure, and was particularly recommended in instances of special worthiness by the late M. du Bousquet of the French Northern Ry., one of the most able demonstrators of the art of handling men who ever held an executive position. His splendid locomotives on the Paris-Calais line, the fastest passenger service for the distance in the world, bear prominently the names of their engineers and firemen. The London, Brighton and South Coast Ry. paints the name of any engineer of proved efficiency in his cab; the London and North Western has it under consideration, and many continental roads have adopted the practice as standard.

It conveys a hidden but nevertheless undeniable appeal to any engineer and fireman, despite the fact that it would be difficult to define its exact nature. It is an assurance on the part of the company that the locomotive in question will remain in possession of its master, and that he will thus be publicly proclaimed as a good engineer just as long as the honor is merited. There is not a man in this world so indifferent as not to be appreciative of this, and who would not be reluctant to see those big gold letters effaced from under his cab windows. It is equally safe to assert that anything he can do will be exercised to keep them there.

A too liberal application of the idea might perhaps lessen to some extent the high degree of honor so conferred, but the Erie can be trusted not to fall into this error. So far there have been but three locomotives on the system thus adorned, but vastly more than three of its engineers are struggling for like preferment. No mistake has been made by this railroad in establishing a plane of superior and recognized merit, and it is a departure which may be followed to advantage in the locomotive practice of any country.

THE HEAVY GRADE LOCOMOTIVE

The interesting paper by F. W. Bach on the design of locomotives for smooth rail working on heavy grades, recently presented before the Institution of Civil Engineers, and which has been carefully reviewed elsewhere in this issue, is well worth a thoughtful perusal despite its manifest theoretical aspect. Some of the points which Mr. Bach makes, notably the reference to the performance of the Mallet compound owned by the Baltimore and Ohio Railroad, are very good, and, while we cannot entirely agree in the majority of deductions which he has drawn, there is still obvious food for speculation on whether the right track is being followed in dealing with this particular problem.

For a thorough appreciation of what the writer of the paper is attempting to bring forth the reader must be in sympathy with the proposition of lighter loads and more frequent trains than those which appeal to the management of our railroads. The diagrams submitted with the paper are ingenious, if not entirely convincing. Nevertheless, although theory has been largely featured, Mr. Bach has not been by any means devoid of the opportunity to convert his ideas into practice. From his assignment to design suitable power for this work he is enabled to draw inferences and conclusions of particular value.

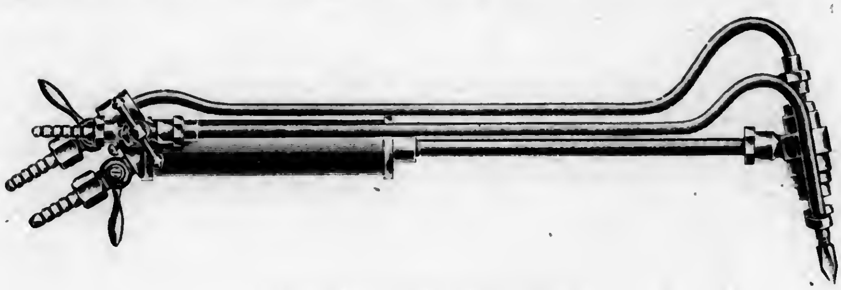
The Oxy-Acetylene Cutting Torch

THE DEVELOPMENT OF THIS APPARATUS HAS BEEN SUCH THAT IT IS NOW ACCORDED GENERAL RECOGNITION AS AN INDISPENSABLE ADJUNCT IN THE SOLUTION OF MANY METAL WORKING AND HEAVY ENGINEERING PROBLEMS.

J. F. SPRINGER.

The value of the oxy-acetylene welding torch has been thoroughly discussed and illustrated in a recent number of this journal,* but it is doubtful if the importance of the device as a metal cutting medium is generally recognized. Within a comparatively recent period it has successfully emerged from the experimental stage along these lines and can now take care of a wide range of work heretofore considered as practically impossible without almost prohibitive costs.

The operation of the torch is no doubt generally understood in its application to welding or "fusing" operations, and an explanation of its cutting properties will no doubt prove of interest in supplementing what has been said heretofore without any elaborate description of the appliance itself, which would merely be in the nature of a repetition.



THE OXY-ACETYLENE CUTTING TORCH.

The method of cutting employed is, briefly, as follows: Oxygen and acetylene are supplied to the welding nozzle as usual. These gases are there mixed together in suitable proportions. Upon issuing from the tip, they are ignited by the flame and are burnt. There are two flames—an inner one, bright and excessively hot; and an outer enveloping flame, dull and comparatively cool. The steel to be cut is heated to a very high temperature by means of the little inner flame, but no cutting of an appreciable amount is done by this flame. The purpose of its application is to get the metal to a high temperature at the point of cutting. A second nozzle terminates quite close to the tip of the heating nozzle. Through this, oxygen is driven under pressure. Consequently, a thin stream of rushing oxygen strikes the highly heated metal with the result that the latter is quickly "burnt up," but only locally. By moving the combination of two nozzles along, the metal will be "eaten" or burnt away. It is quite possible to make a narrow and deep cut.

Assuming that the action of the inner and the enveloping flame are understood, it may be said that the operation of cutting with the torch is not unlike sawing. The flame and oxygen jet are directed downwards with the upper part (as the position now is) inclined slightly towards the direction in which the cut is to be made about in the same way a board is sawed with a hand saw, except that with the flame and jet the obliqueness is perhaps, as a rule, considerably less. The material removed flows down and off, just as with saw dust. The forward profile of the cut, however, is not straight but curved, and this curve swings backward more and more as the bottom of the cut is approached. All this is, of course, different from the cut made by the ordinary saw. But the two procedures resemble each other in that the cut extends clear through from upper side to lower. It must not be understood in this connection that the cutting goes on slowly as a steel bar, 6 inches on a side, has been cut through in 1½ minutes. The consumption of oxygen is not at all extravagant. For this cut 10 cubic feet were used, costing about 25 cents, but it may be said that this is, perhaps, an unusual case and can scarcely be equalled every time. It is recalled that the expense of cutting a 6-in. shaft, including, no doubt, the cost of the oxygen and acetylene used in heating as well, was 37½ cents.

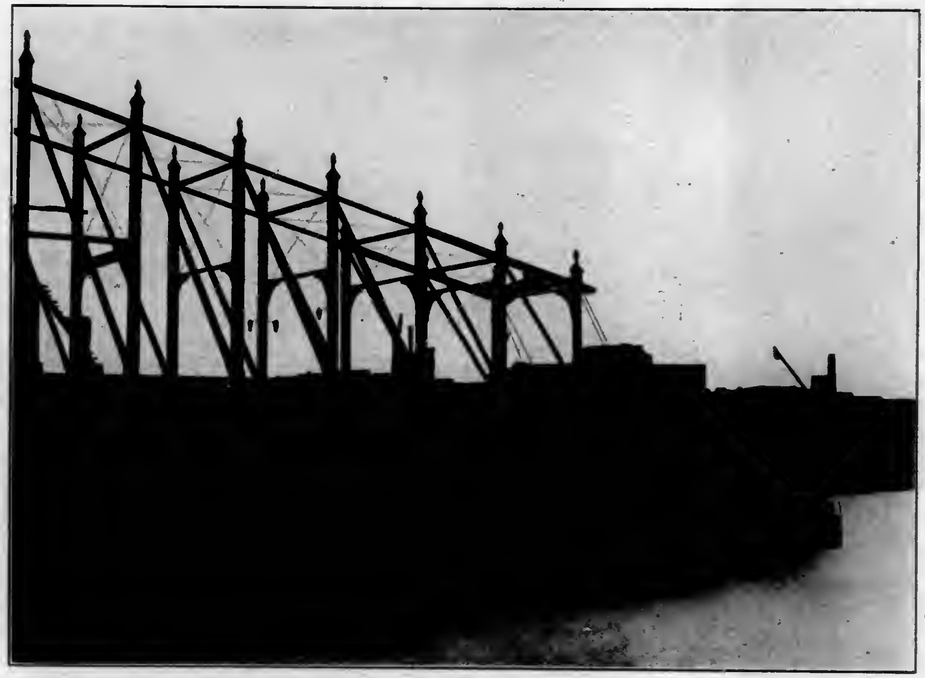
In one of the illustrations is a view of the cutting operation while it is going on. The I-beam in this case is 15 inches wide, and such a beam may be cut through in less than 3 minutes. The flying *debris* is to be seen streaming off to the right. It will be observed that there are two tanks, both containing oxygen. The reason for two tanks is that the pressures advisable are different for the heating torch and for the cutting attachment. Both are used in carrying out the cutting process. The oxygen supplied for the heating part of the procedure in cutting the 6-inch square bar was probably at a pressure of no more than 16 or 18 pounds per square inch, and the oxygen flowing through the cutting tip was at a pressure of 125 pounds. When the cutting is light, there is greater approach to equality in the two pressures. Thus with very thin sheets of ½-in. thickness or less, the pressure of oxygen passing through the heating nozzles will range, say, from 14 to 18 pounds; while that passing through the cutting nozzle will have a pressure of, say, 20 pounds. For sheets varying from ½ to 1½ inches, the oxygen of the heating jet will be

CUTTING A FIFTEEN-INCH I-BEAM.

* See AMERICAN ENGINEER, November, 1910, page 431.

about the same as before, while that of the cutting jet will be increased to, say, 30 pounds.

One great advantage the oxy-acetylene method of cutting possesses is the ease and economy with which it can be applied in difficult situations. Those who have to do with the clearing away of steel wreckage know what such difficulties mean, or those who have to dismantle steel structures that are to be abandoned. An example of dismantling occurred in connection with the removal of a portion of the steel bridge crossing the Harlem River in New York City at 136th Street. The central portion of this structure was used as a draw. It was this section where the oxy-acetylene cutting process was put into operation, and steel to the amount of 450 tons was involved. There were regulation I-beams, riveted I-beams, and riveted vertical supports. The cutting process was employed to divide the structure into seven manageable parts.



STEEL BRIDGE DISMEMBERED BY CUTTING TORCH.

There were two outfits employed. A large floating derrick would be manœuvered to take the weight of the section about to be removed. The several beams would then be cut and the section lowered to the grillage of the fender, where further dismemberment would be carried out by other means. The first two sections thus cut and lowered averaged about 25 tons each. The next two weighed about 66 tons each. The four central columns were lowered together. In dealing with the swing span it was found necessary to block up one end, the weight being unevenly distributed. The first cuts were then made at the other end. The management of this matter was perhaps the most difficult of all, because of the care necessary. However, all operations were executed in a week's time, and the long span completely removed. It is said that the removal by former methods would have occupied from six weeks to two months. The consumption of gas was quite moderate. Of acetylene, about 450 cubic feet were used; of oxygen, about 1,500 cubic feet. The total value of the gases was about $42.

Another illustration of the ease of application of the oxy-acetylene cutting process was furnished at 95 William Street, New York City. Here it was desired to remove a large steel tank constructed of ½-inch sheets. The tank was 4 x 8 x 10 feet in size, and so situated that a sledge could not be used to cut the rivets. It seems that it would be possible, however, to move it a short distance, cut off a section, then repeat the moving and cutting, and so on. This would scarcely have been a rapid method, but with the Davis-Bournonville apparatus the whole job was done in one day. The whole was cut up into 13 pieces, that is to say, each end was cut into two pieces, and each side and the bottom into three pieces. It is said that to have dealt with the matter in some other way would have taken a week or ten days.

Nickel steel, as is well known, is very tough, and consequently is difficult to cut by ordinary means, but the oxy-acetylene process knows but little difference between nickel steel and others. Certain portholes had to be cut recently in nickel steel plate 15/16 in. in thickness. It is said that by the old method of chipping, even though the most up-to-date tools should have been used, each porthole would have required two or three days' work. With the oxy-acetylene cutting appliances, 125 such holes were cut in an average time of about six minutes per hole. That there is a tremendous economy here is very evident.

It will readily be understood that, in the great variety of cutting work, the manipulations required must be quite diverse, although there is a good deal of such work where the conditions remain pretty constant. In such cases it will often be advisable to use mechanical means for handling the cutting apparatus. A precision can be attained when mechanical means are employed that would either be difficult of attainment otherwise, or would consume too much time. There is a mechanical device with which the cutting torch can be moved across sheet steel by means of a hand screw. With ½-inch steel plate and 15 pounds pressure on the cutting oxygen, a speed of 1½ feet per minute can be attained; with 9/16-inch plate, 15 pounds pressure, 1¼ feet per minute; with ¾-inch plate, 25 pounds pressure, 1 foot per minute; 1-inch plate, 32 pounds pressure, 1 foot per minute; 1¼-inch plate, 42 pounds pressure, 1 foot per minute. The cuts are only about ⅛ inch wide. Heavier work can be done, as already pointed out. In fact, a thickness of 14 in. has been cut, and it is impossible to say where the limit is.

Another type of work is in connection with steel castings. The risers on these can be cut away by this process. It is possible to compare results here with what has been accomplished with the saw. Using the saw, 181.69 cubic inches have been cut in 405 minutes. This seems to be the actual cutting time, and the 181.69 cubic inches to represent the day's work. The labor cost, $1.90; grinding the saw, $0.86, so that, excluding power, the total cost was $2.76. The average cost per cubic inch would thus be $0.0152. With the oxy-acetylene cutting torch, 135 cubic inches

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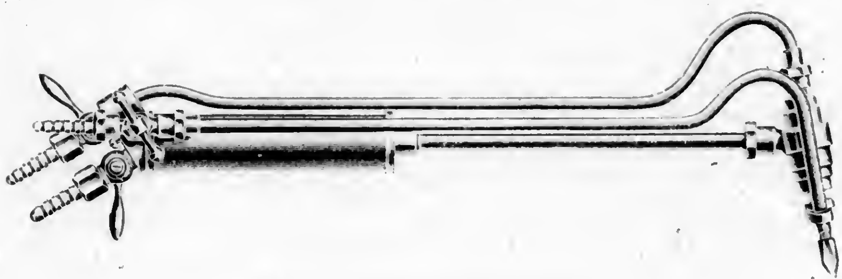

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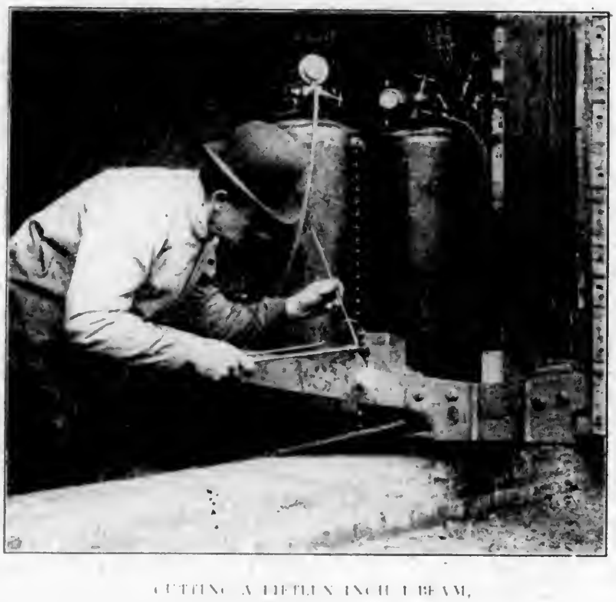

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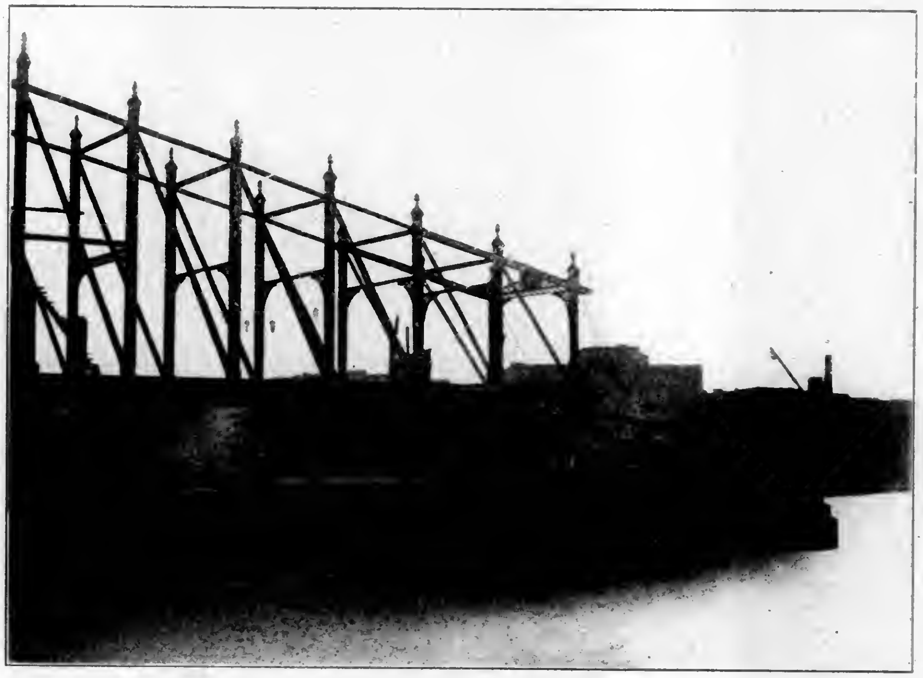

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were cut per hour. The labor was estimated at 25 cents per hour, the acetylene at one cent per cubic foot and the oxygen at two cents. The expense per cubic inch of steel was found to be $0.0080, or but little over half that with the saw. The foregoing data are based on results at a plant where steel castings are made

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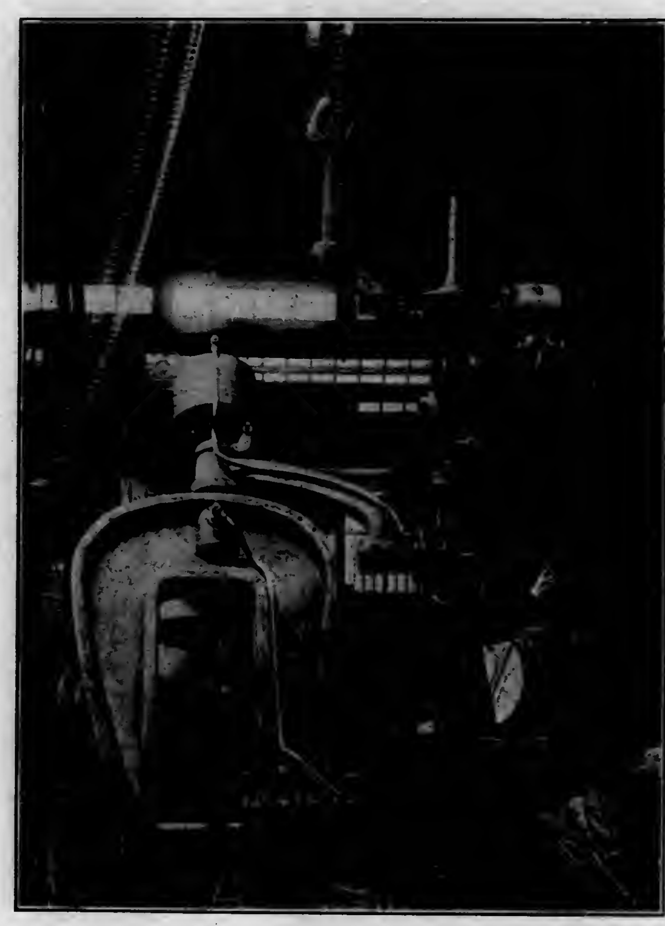

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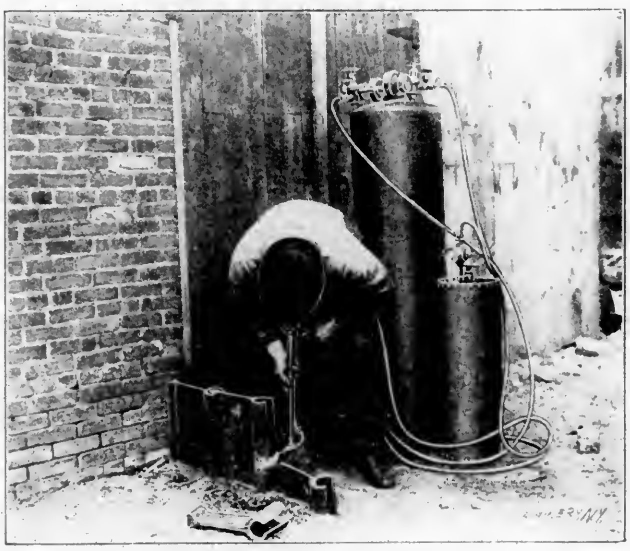

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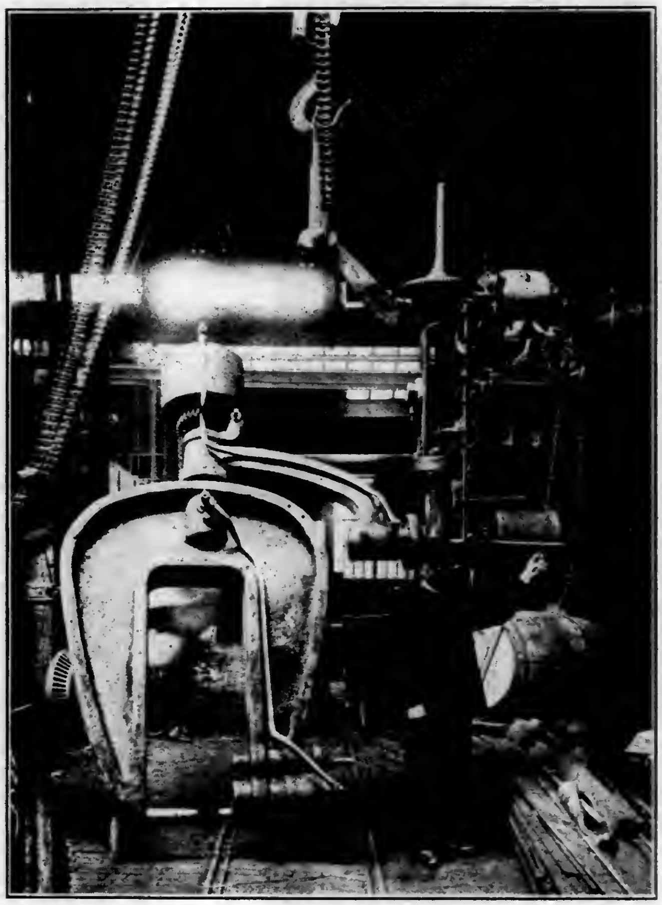

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Locomotive Fuel Economy

ABSTRACT FROM A MOST VALUABLE PAPER PRESENTED BEFORE THE RAILWAY CLUB OF PITTSBURGH, IN WHICH THOROUGH INSTRUCTION AND DEMONSTRATION ARE ADVOCATED AS POTENT FACTORS.

A. G. KINYON.

Instruction is the key-note to fuel economy, but to be effective, it must be followed by supervision and demonstration. Instruction by means of books on fuel economy is good, instruction by correspondence courses is also good, and instruction by lectures direct to the men is best, but if any or all of these made up of proper information, are supplemented by practical demonstrations on the engines and followed up by constant supervision, the nearest to ideal conditions will obtain. Instruction in whatever form should be given, not only to engineers and firemen, but to roundhouse foremen, boiler makers, hostlers, hostler helpers, fire builders, engine watchmen, grate men and fire cleaners. And if officials of the operating and mechanical departments attend the classes occasionally, it will have a good influence, as well as keep them posted as to what instruction is being given and so be in a position to give support in having the instructions carried out.

Upon the roundhouse foremen, boiler makers and grate men should be impressed the importance of having the draft appliances, grates, flues and all parts that make for fuel economy, in proper condition when the engine goes out, and a clear understanding of what proper conditions are, should be insisted upon. Hostlers, hostler helpers, engine watchmen and fire cleaners should be instructed in proper methods for building the fire, its care up to the time of delivery on the going out track, and the condition it should be in when delivered, proper methods of cleaning the fire, and when these men are in line of promotion to the position of fireman, they should receive the same instruction given to firemen.

The present method followed on most roads of sending a new man out as a student fireman to learn to fire from a fireman who possibly may be making his first trip for pay, is the poorest possible. It is the failure to do successful work when so started that causes so many to become discouraged and quit, and thus keep the service filled, particularly in a busy season, with green, dissatisfied and unsatisfactory men. And this practice brings about a method of firing by which the fireman keeps up steam when all conditions are right, but which is very extravagant in coal consumption, and when adverse conditions are encountered, result in steam failures. All this would be obviated if proper methods were followed from the start. It should be the aim to get these green men into the instruction car before they make a trip and give them a clear understanding of the theoretical part of the work, as well as an explanation, so far as possible, of the practical part, and then their first two or three trips, or more if necessary, should be made with the demonstrator instructor to give them a right start, and a right start is of the greatest importance in any undertaking.

The demonstrator instructor should have only such territory and men under him that he can ride with each man at least two or three times a month and in this way keep them up to proper work. While it is a fact that the engineers and firemen receive the highest pay outside of official positions on the road, it is also true that the majority of them need, like other employees, direction and supervision. No management would think of starting men in the shops without some direction and supervision, and the supervision would be continued at all times. The man, who by his faithful work, shows that he does not need supervision, is the one who is promoted.

The cost for material for repairs to our locomotives is only about 40 per cent. of the cost of fuel to operate them, while the cost of labor for repairs and terminal care is only 46 per cent. of the cost for fuel and labor to operate our locomotives, so it would seem reasonable to assume that the same amount of supervision be had over this labor and material as is had in shop management, but have we? No, far from it; it is safe to say that for every 20 first-class workmen in our shops we have a foreman. How many foremen or road foremen of engines have we on our 57,000 locomotives? No exact figures are obtainable, but we think that one road foreman for every 150 engines is a safe estimate. In the face of these figures no intelligent man can deny the fact that great saving can be brought about by closer supervision of the men on the engines. We believe there is work enough outside of the matter of fuel economy for the road foreman and it would be one of the best possible investments to train a corps of men especially for this work, and have enough of them so there would be at least one for every fifty crews.

The first essential is a well equipped instruction car, fitted up with apparatus and in charge of a competent instructor, who, where possible, should be a practical engineer. The difficulty of securing practical men as instructors will no doubt be great, but arrangements could be made with some of our technical schools to train men in the theoretical part of the work, or supply instructors to work with the practical man in the education of the men. In fact, we believe that the extension department of our state college would be only too glad to train men along these lines, could they be assured of openings for them, or the Scranton schools, through their railway department, would either instruct the men direct, or furnish instructors.

Besides apparatus for instruction on the principles of the chemistry of combustion, other apparatus should be provided for distilling the gas from coal, and catching some of it, and showing how it can be used to advantage, or how much or all of the gas may be lost by improper methods of firing, evaporation test apparatus in which some of the gas from the coal can be burned, and the economy of a slow rate of combustion over a rapid rate shown. Show that the rapid rate is the one where the black smoke is made, and that the black smoke is the carbon of the hydro-carbon gases, and represents a loss of 14,500 B.t.u. for every pound so escaping, also that with black smoke is escaping quantities of partially burned carbon in the form of a colorless gas known as carbon monoxide, and that each pound of carbon so burned represents a loss of 10,000 B.t.u. That the formation of the smoke and the carbon monoxide is due to supplying coal faster than the draft appliances can supply oxygen through the medium of the air to burn it. The matter of draft and draft appliances and their adjustment should be gone into with the help of stereopticon pictures. These pictures should show the interior of the firebox with the fire burning under different conditions, a view of the front end as well as the boiler in longitudinal section. The necessity of having the air come in through the grates to have the oxygen thoroughly mix with the fuel elements of the coal should be brought out strongly, and in this connection the necessity of swinging the door after each shovelful of coal is put in, should be impressed. Also that the air mixes best with the coal if a light fire is carried and the fresh fuel added in thin layers. Views should be shown on the canvas picturing the improper fire as well as the proper one.

A fire with a hole in it should be shown, and the exact reason such a fire will not produce heat explained; also a clinkered fire, and what the presence of the clinker means and how to avoid it. A picture showing a tender properly coaled and trimmed should be shown, and any other views that local conditions make desirable. The importance of co-operation of the engineer and fire-

man should be taken up and strongly impressed on the men. Instruction in this way, or when this is not convenient, instruction by means of carefully prepared instruction books, will lay the foundation for the most important part of the work, namely, the demonstration on the engines in actual service. This world is certainly filled with many Missourians and a large number of them are to be found on our locomotives, so many in fact that I sometimes wonder if that state is not becoming depopulated by emigration, as so many of the men have to be shown.

The demonstrator instructor should be an engineer of not less than two years' experience in that position, who thoroughly understands the theoretical part of the business, and who is able to take the scoop and fire an engine over the entire division if need be, to show that the theoretical part is practical in service, and when the two are combined far better results will be had than with either alone. Show how the fire should be built up at leaving time, so that when stirred out or broken up, as the start is to be made, that a clean bright fire will be had, one that is even in thickness over the grates, and only just heavy enough to stand the work the engine is to do. Show how if the fire is bright all over and not too thick, the air will come through equally at all points, the fire will not be torn in holes, and much less coal burned than if the start was made with a dull, heavy fire. That by firing light and often, and taking pains to break up the large lumps, and covering as large a surface as possible with each shovel of coal, and the door closed after each shovelful, that much less coal will be used, an evener steam pressure maintained with less labor, smoke eliminated in a great measure, and his work for the company more economical and satisfactory.

The practice of leaving the door on the latch after each scoop of coal or after each fire to prevent smoke, if effective, is simply a second wrong to be made aright, the first error being in putting in too much coal at a time or too often. The truth is that there is a wrong understanding on the part of many as to how or under what circumstances black smoke is formed. Many believe that the smoke is formed on account of low firebox temperature, when in fact it is impossible to form black smoke unless we have a temperature of at least 1,800 degrees F., for the reason that the smoke is the unburned carbon of the hydro-carbons and does not become visible until it is separated from the hydrogen, and this separation does not take place until a temperature of 1,800 degrees is had. At this temperature, if there is an abundance of oxygen present and in touch with these fuel elements, they will both burn, and only colorless gases will be produced. In most cases, where opening the firebox to prevent smoke is effective, it is due to the fact that the cold air admitted above the fire in this way chills it below this splitting-up temperature and the gases escape in their compound form, and we then not only lose the carbon, but the hydrogen as well, and will have to use considerable more coal to make up for this loss.

Show him that the proper time to add fresh coal is after the gases of previously added coal have all burned off, and the fire is burning with that white incandescent heat that is so blinding when you look at it. Call his attention to the fact that the coal must be added at just the right time, and if so added there will be no danger of the fire getting away from him. This is one of the hardest things to teach a man and can be done only by practical demonstration. The writer has had many firemen say: "I did not believe it possible to fire an engine with such a light fire and would not have dared to try; but now I see it can be done, I am going to do it." Abuse of the fire on the part of the engineer in allowing the engine to slip, leaving the lever down too long in starting the train, or failing to hook up when tippling a hill, or upon striking a sag or flat place, is often the cause of heavy fires and extravagant methods of firing followed by so many firemen. If the fireman has the experience of having his fire taken away from him once or twice by such practice, he will ever afterward be inclined to go "loaded" for all comers, as he would rather be censured for having too much coal in the firebox than for not having enough, even though the heavy fire will not produce as much steam.

The harmfulness of this wrong practice on the part of the engineer should be pointed out to him very clearly and proper methods of handling his engine insisted upon. The importance of shaking the grates to keep them free from ashes and clinkers as far as possible, should be impressed on the fireman, but at the same time he should be cautioned not to shake them too often or too hard. The fireman should be taught to use his head, to figure ahead and have the condition of his fire right for different parts of the road, so that when a shut-off is to be made the fire will have burned down so that if the engineer has figured to have room in the boiler for water and increases his water feed before closing the throttle (if he does not do this he should be instructed to do so), the pops will not lift and black smoke will not trail over the train. While it is quite proper and essential to let the fire burn down under these conditions, he should also be impressed with the necessity of not going to an extreme, so that when steam is to be used again there might be a failure of pressure, or more coal required to build the fire up again than was saved by allowing it to burn down.

We think it is understood that all efforts to fuel economy must be subservient to the conditions necessary to pull the tonnage and make the time required, and if one method will do this and another will not, the most effective method must be followed, although it has been our experience, when the engine is in even fair condition, the best results will be had when the light and frequent method of firing is followed. The engine crew must work together to get the best results, so the instruction should be understood alike by them. They should figure, upon reaching a terminal, to have the fire in such condition that after the engine has been left on the terminal track by them, the pops will not open and waste a lot of fuel, neither should the water be left too low or the fire so low that it will die out, particularly at the flue sheet, before the engine will have been taken care of by the hostler or engine watchman. The fire, water and steam pressure should be as outlined in a previous paragraph on "Condition of fire at completion of trip."

The exact relation of the traveling engineer or road foreman to the demonstrating instructor, or just what his title should be, is a matter that will have to be worked out locally. The title certainly should not be traveling fireman on account of lack of prestige such a title would produce, and the duties of this man should be apart from those of the road foreman. On the Erie this scheme is being worked out experimentally on two divisions by a man on each division with the title of supervisor of locomotive operation, who has full authority over the men so far as the proper operation of the locomotive is concerned, and who looks after the draft appliances as well as other parts or conditions that make for fuel economy, and they are getting remarkable results.

We believe that no man should be placed in the position of demonstrator instructor who cannot take the scoop and demonstrate every point, or if unable to do so, point out clearly what improper condition prevents proper results being had. While we do not believe he should fire an entire trip at any time, unless in case of emergency, he should fire far enough to demonstrate to the doubting ones that the method of light and frequent firing can be followed, not only for a few miles, but for many, not only in light service, but in the heaviest kind of service. He should also impress upon the fireman when he takes the scoop that it is not for the purpose of relieving him of his work, but is purely instructive, and he will be expected to follow methods and get results as shown. In riding on poor steaming engines, to determine what the cause of steam failure is, he should watch the operation on the part of the engineer, test for valve and cylinder packing leaks, and fire the engine himself to determine accurately where the trouble is. The engineer should be instructed on these points as well, so that the common report of "engine don't steam" will be supplemented with an explanation of "why," so the roundhouse foreman will know what to do to overcome the trouble. He should have the supervision of the hostlers, fire cleaners and engine watchmen and the condition of the fires at terminals. His report on quality of coal used and manner of charging it to engines, should have much weight.

TOOLS FOR FLUE AND SHEET REPAIRS

Western Ry. of France.

Flue and firebox troubles which have been particularly prominent in connection with the locomotives of certain European railroads have of late acted as the stimulus for a vast amount of ingenuity in the evolution of special devices for performing work, and for correcting abnormal conditions. Some of these devices are radical departures from those employed in flue setting in this country, and the methods of heavy firebox repair work exhibit a decided variance, but both the tools employed and the operations are very interesting, and at least clearly indicate that those on the other side in charge of this work are not lacking in resourcefulness.

THE GALLON FLUE SHEET TOOL.

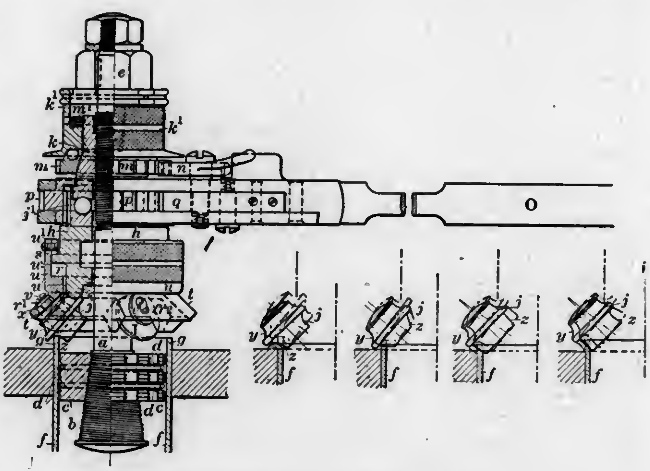
M. Gallon, who is connected with the shops of the Western Ry. of France, has devised and patented many clever appliances for use in flue and flue sheet work which have been adopted by his road, and which are attracting considerable attention elsewhere from the good results which have been achieved. One of his very convenient tools for setting flues is shown in the second illustration. The ordinary method practised prior to its appearance consisted of the use of a dudgeon which dilates the flue and fits it tight inside the hole in the flue sheet. This is followed by the beading process, in which a hammer is used to turn over the bead, and the latter finished with a hand or air beading tool. It was well appreciated by M. Gallon that this work which must be done by shocks is quite liable to loosen the flue in the hole, and in fact to frequently necessitate the re-application of the dudgeon after the bead had been formed. This in turn increases the length of the flue, so that the bead is no longer in contact with the sheet.

It was also shown conclusively through experience that it was not advisable to use the dudgeon too frequently upon the same holes in view of the fatigue induced in the flue sheet and the liability to put it out of shape. Tools of various kinds have been devised abroad for carrying out the setting of flues in a better way, but for many reasons these do not seem to be used to any extent. Either they are too light, and will not answer for the steel flues which are now used for locomotive work, or else they cannot follow the inequalities which many flue sheets exhibit after a certain length of service. Such sheets are frequently deformed to a very great extent in European countries, and are far from affording flat surfaces, so that an appliance suitable for new work will not do for repairing flues.

The flue setting tool designed by M. Gallon consists of a central rod (a) whose lower end carries a conical threaded part (b). On it are mounted the split rings (c) carrying the elastic rings (d). The upper end of the rod has a head (e) by which it can be turned. When this is done the conical part spreads the rings (c) which are strongly pressed against the sides of the boiler flue (f), thus giving a solid fixed point for the appliance to work against. The flue is also held well in place so that it cannot be put out of shape while the tool is turning down the bead (g). Along the rod is a cup shaped collar (h) which carries below a circular rim (i), the latter used as a rolling surface for the set of rollers (j) doing the work. Above it carries a depression with ball bearings (j) which are pressed down by a tightening nut (k). This latter screws upon a thread (l) on the main rod and is worked by a friction collar (m) receiving pressure from a milled hand nut (k') by means of a small bearing. A ratchet wheel (p) worked by a handle (o) carrying a pawl is worked on the main collar (h) and serves to turn it. The box carrying the rollers (u) is mounted upon the main collar as indicated, and there is left a certain play at "u1," "u2" and "u3" so as to allow this box to incline somewhat. The rollers (j) with their pins (v) are mounted so that the pins run in holes in the sides of the box so as to give a still further play. The rollers are grooved at the top so as to fit upon the rolling way (i). On the same rollers is a second groove (z) which is designed so as to work upon the end (g) of the flue (f) and to turn it over in the proper way.

The appliance is worked as follows: It is first blocked in place by fitting it in the end of the flue, and by expanding the rings so as to hold it tightly. The main lever (o) is then worked, and it carries with it the pawl (n) by means of a lug so as to operate the ratchet (m), making the nut (k) turn upon the main threaded rod. To this end a suitable pressure has been given by turning the milled nut (k') by hand. Thus the nut (k) will give a pressure upon the lower collar (h) and the rollers through the ball bearings. At the same time the main lever turns the principal ratchet (p) and therefore the collar (h). By means of the lower rim (i) the rollers are turned about by friction, and work upon the end of the flue so as to turn it down as desired. When the pressure of the nut (k) upon the rod (a) becomes sufficient, the ratchet (m) is released by slightly unscrewing the hand nut (k'), and the tool can thus be rotated without advancing it, or can be advanced as desired so as to complete the operation. Such advance is controlled by the hand nut (k') as through this is thrown on or off the advancing ratchet (m).

The rollers can take the necessary inclined positions for the work owing to the play which is allowed, but in all cases the rollers rest upon the guiding surface (i), and have their side thrust against the rim of the collar. Rollers with different profiles for carrying out various classes of work are shown in the illustration to which the above references are made. When



DETAILS OF GALLON BEADING TOOL.

the operation is finished the pawl (n), which is double, is turned about so as to unscrew the nut (k) and this loosens up the appliance so that it can be removed and placed upon the next tube. Owing to the good work of this tool it is now used in the Western Railway Co.'s shops, and allows of turning down the ends of steel flues to form wide beads. With that company the greatest diameter of steel flues is 2¾ in.

with a thickness of ⅛ in. to 3/16 in. In cases of this diameter the flue ends project from the sheet before beading ⅜ in., while for a 2-in. flue the projection is ¼ in.

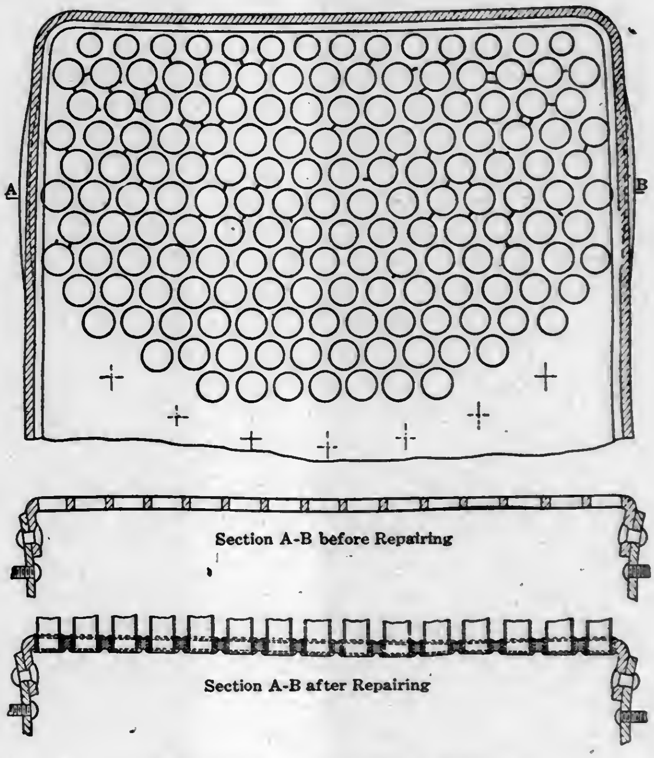
The tool shown in the photograph is the same exactly as that which has been described, except that it contains an inverted ball stem, for use where bushings are used in flue holes before the application of the flue, and which must be beaded on the water and on the firebox side. It is of course apparent that to use this tool the flues must be removed, and in that contingency it adequately forms a bead for the bushing on either side of the flue sheet. A considerable progress in repairing cracked and distorted firebox sheets has been made in France through the Gallon system, in which this last mentioned tool plays no inconsiderable part. In the instance of cracked webs between flue holes the plan pursued is to fit entirely over the damaged area of the flue sheet a sheet of copper, and to secure this latter to the flue sheet by means of bushings in each flue hole, flanged on both the water and the fire sides of the sheet. In view of the fact that a very thin sheeting is employed it must fit down upon the flue sheet surface, no matter how distorted or bulged the latter may be.

So far as securing this sheeting is concerned, M. Ragno, an engineer of the Italian State Railways, uses in the flue hole a light copper bushing made of a section of tubing, and fits it into the hole, afterwards turning the projecting ends down on either side of the flue sheet. An improvement has been made in this method by M. Gallon, who uses steel bushings instead of copper. Through the use of the tool last mentioned he can flange the ends so as to give a wide bead which will hold the copper plating very tight. He modifies the method of holding the tool, which the photo clearly indicates, by substituting the inverted ball stem which has been mentioned, and which is extremely to the point in view of the fact that only a simple bushing need be considered here. The main rod screws into a half-round base which fits upon and pulls against one side of the flue sheet while the other side is being beaded as has been described. Except for the fact that the rollers are designed for forming a wide bead the construction of the applaince remains the same as that which has been described in detail. The inside flange is first made, then the outside, using conical holes to start with, and with the larger opening outward. With the flues all out, and it is presumed in this condition that they will be all removed, copper sheeting can be used on either side of the flue sheet. After bushing the holes with this tool as has been described the boiler flues can be inserted in the bushings and beaded in the usual way with the same tool as that shown in the line drawing by simply substituting the screw end for the inverted ball stem.

Some very clever repair work is being done on the French Western through the use of these ingenious, even if somewhat complicated tools. One of the illustrations shows a back flue sheet in very bad shape. It will be noted that many webs are fire cracked and broken, and that on the section A-B a bulge exists sufficient to practically condemn it in our practice, or at least to warrant a straightening operation of more or less magnitude. This sheet was in fact considered as out of service, but by the Gallon method, and with the tools which have been described and illustrated, it was repaired and returned to work, and has been running for over 18 months, and holding out well. In this case copper bushings were used in the flue holes before the steel bushings were applied, and copper plating was used all over the outside or firebox side of the flue sheet.

These repairs are not entirely applicable to American practice as we are not particularly troubled with broken bridges between flue holes. As a rule when these latter arise it is from some bungling in trying to straighten a bulged back flue sheet, and with the sheet being insufficiently heated it breaks through three or four webs when the draw is applied by means of the screw rods between the front and back flue sheets to straighten the firebox sheet.

It is doubtful indeed whether in American practice it would be considered advisable to run a flue sheet in such condition, but the fact remains that this was repaired and returned to service, and the two comparative cross sections are more emphatic than words can possibly be in illustrating the gravity of the situation and the nature of the repairs. A number of comparative tests show that repairs made by this method have been of great advantage, and it has been claimed that 80 per cent. is realized on material and labor, over that represented by a renewal of the sheet. The time for which the boiler is thrown out of service is also lessened some 60 per cent., even although the flues must be entirely removed. M. Gallon states that over 20,000 bushings have been applied by his method in France and elsewhere upon 283 back flue sheets.



FLUE SHEET BEFORE AND AFTER REPAIRS.

OIL AS FUEL IN LOCOMOTIVES.—The use of oil as fuel on the railroads of the United States during the last year greatly increased, the consumption by the roads in 1909 amounting to 19,939,394 barrels, an increase of 3,050,324 barrels, or 18 per cent. over the previous year. The oil used by the railroads is mostly crude. After a thorough investigation by an expert for more than a year, the Great Northern has decided to use oil as fuel on practically all its locomotives west of Leavenworth, Wash., in the Cascade Mountains.

STILL ANOTHER GREAT STEAMSHIP.—The new Cunard liner will be propelled by turbines operating quadruple screws. Her coal capacity will be 6,500 tons and her total displacement 50,000 tons—5,000 tons more than that of the *Olympic*. The design of the vessel will, it is said, include a double bottom so arranged that she may carry oil fuel should the introduction of such a method of raising steam appear advisable. Needless to say, the fittings throughout will comprise every luxury, including a swimming bath, a theatre, and a daily paper. The accommodation will provide for 650 first-class passengers, 740 second-class, and 2,400 third-class—a total of 3,790, which compares with 2,500 in the *Olympic* and 2,200 in the *Mauretania* and the *Lusitania*. The cost of the vessel will probably reach close on to $10,000,000.

THE POWER OF A LOCOMOTIVE BOILER

During the last decade a revolution in opinion has taken place in England with regard to the size of locomotive boilers. It has been more and more recognized that the power of a locomotive is limited by the amount of steam which the boiler can supply, and in this respect there is a tendency to fall into line with American practice where large boilers are the rule. In this article the writer proposes to trace the relation between the size of the boiler and the power developed by the locomotive.

Before proceeding any further, it may be as well to review briefly the conditions under which the locomotive boiler has to work. In the first place, owing to restrictions of space and weight, it must be an enormously rapid steam generator. This necessitates a large area of heating surface compared with the amount of water carried in the boiler. Secondly, owing to the small space available for the grate, a high rate of combustion must be maintained. This latter condition is rendered possible by the action of the blast-pipe, and also by the very efficient circulation promoted by the vibration of the engine. It is impossible to get the same rate of combustion on land boilers as on locomotives, owing to the water being unable to take up the heat sufficiently quickly, the result being unequal expansion, local overheating, and consequent leakage. It is this very efficient circulation which, by enabling the water to take up the bulk of the heat offered, maintains the efficiency of the locomotive boiler at a level vieing with the best land and marine boilers in spite of the distinctly unfavorable conditions for economical fuel consumption.

In laying out the design of a boiler it will be found the leading dimensions are governed almost entirely by the wheel arrangment of the engine, and, in the case of large boilers, by the limits imposed by the loading gage. The length of the boiler must be considered in conjunction with the wheel-base. The front tube-plate is generally level with the back of the cylinders, and the length of the barrel is fixed, in the case of four or six coupled inside cylinder engines, by the amount of room required for the cranks. This generally necessitates the fire-box being sloped up at the back to clear the trailing axle, although, in the case of small engines with a short fire-box, it is sometimes feasible to drop the fire-box between the axles. The height of the boiler will be governed by the relation of its diameter to the size of the driving-wheels, although sometimes a boiler may have to be raised in order to get sufficient depth for the fire-box when the latter is carried over one of the axles, and the diameter of the wheels is large. The diameter of the boiler is generally as small as is consistent with obtaining sufficient room for the tubes, the number and diameter of which will depend on the heating surface required.

The power developed by a locomotive boiler is limited chiefly by the size of the grate, and by the maximum rate of coal consumption. As regards the latter point, through the kindness of Mr. S. D. Holden, the locomotive superintendent of the Great Eastern Railway, the writer was recently afforded opportunities of noticing the rate of firing on express trains, and as a result of his observations he is enabled to state that the rate of coal consumption reached as high a value as 150 pounds per square foot per hour for a period of 10 minutes, the average on a non-stop run of 90 minutes' duration being 90 pounds per square foot per hour. The size of the grate was 21.6 square feet, and the load behind the tender was 300 tons, the average booked speed being 45 miles per hour.

The amount of water required by a locomotive is usually stated as being from 22 to 30 pounds per indicated horsepower-hour, the rather excessive amount being generally credited to the very wet steam which the locomotive boiler is accused of supplying, some authorities stating that the dryness fraction is as low as 60 per cent. In order to obtain some light on this debatable point, the writer recently calculated the steam consumption from a set of indicator cards taken from an express engine, and, assuming different dryness fractions, plotted the cards on an entropy chart until the horsepower of the entropy diagram agreed with the horsepower of the actual card.* As a result he found that the average wetness of the steam during admission did not exceed 10 per cent., even when working heavily with the regulator wide open. The steam consumption measured from the indicator cards varied between 16 and 18 pounds per indicated horsepower-hour, the higher figure being for a cut-off of 25 per cent., hence the water consumption to be debited to the cylinders would be about 19 pounds per indicated horsepower-hour. Nevertheless it is a fact that the water consumption, as measured from the tender, is from 22 to 25 pounds per indicated horsepower-hour, and hence it is necessary to see what becomes of the remainder. Some of the steam is used by the injectors and also by the brake, and a certain amount is wasted at the safety-valves, and there is also a loss of water at the injector overflow. Reckoning that the steam used by the injector is 1 pound for every 10 pounds of water fed into the boiler, which means 2 pounds per indicated horsepower-hour accounted for by the injector, and putting the supply to brakes, waste at safety valves, and injector overflow, at 10 per cent. of the total, say 2½ pounds per indicated horsepower, we have:

Steam used by cylinders per I. H. P. hour	=	19 lbs.
" " injector per I. H. P. hour	=	2 "
" " brakes, etc.	=	2½ "
Total		23½

As, however, the chief demand made on the boiler while running is that of the engine, the brakes and safety valve losses only occurring, as a rule, when steam is shut off, we shall be justified in assuming that the average call for steam is 21 pounds per indicated horsepower.

The evaporative power of the boiler is generally given in pounds of water evaporated from feed temperature per square foot of heating surface per hour, and depends on the rate of coal consumption and the ratio of heating surface to grate area. This ratio varies between 60 and 100, the average being from 75 to 80. With a ratio of less than 60, the flue area will probably be so much reduced as to require a sharp blast, as was exemplified in the oft-quoted experiments on the French boiler, in which it was shown that for the same coal consumption the evaporation was approximately the same with half the tubes plugged up as with all the tubes open. It does not generally seem to have been noticed, however, that from 50 to 80 per cent. more draft was required to maintain the same coal consumption when half the tubes were plugged up. As regards the upper limit of the ratio, viz., 100, if this is obtained by crowding the tubes together or by making them of abnormal length, the advantage will be more apparent than real. Crowding the tubes together obstructs the circulation of the water, and abnormal length will result in increased frictional resistance for the hot gases, and in addition the last foot or two of length is not of much heating value, owing to the reduced temperature of the gases. In the following investigation the ratio of heating surface to grate area will be taken as 75; that is to say, the heating surface is 75 times the grate area.

Before proceeding any further, it will be as well to calculate the amount of water evaporated per pound of coal, and to do this we will assume that the steam pressure is 170 pounds gage, the dryness fraction 0.9, the feed temperature 60 degrees F., and that the boiler efficiency is 70 per cent., with coal having a calorific value of 14,000 British thermal units.

From the steam tables the sensible and total heats of steam at 170 pounds gage, when evaporated from water at 60 degrees F., are 348 and 1136.3 British thermal units, respectively, so that the heat required to evaporate 1 pound of steam of 0.9 dryness,

$$= \frac{1136.3 \times .9 + 288}{10} = 1051.5 \text{ B. T. U.}$$

and the water evaporated by one pound of coal

$$= \frac{14{,}000 \times .7}{1051.5} = 9.3 \text{ pounds.}$$

If C be the coal consumption per square foot of grate per hour, then the evaporation per square foot of the heating surface per hour

$$= E = \frac{9.3 \times C}{75} = 0.124 \times C \text{ pounds.}$$

As the power exerted by a locomotive is generally given as so many pounds tractive force at a certain speed, it will be convenient to reduce the boiler power to its equivalent tractive force. To do this, it will be necessary to assume that the rate of evaporation is constant, although, strictly speaking, this is not the case, as the power of the boiler increases with the blast of the engine.

Let T be the cylinder tractive force in pounds.
I. H. P. be the cylinder indicated H.P.
V be the velocity in miles per hour.

$$\text{Then } T = \frac{\text{I. H. P.} \times 33{,}000 \times 60}{5280 \times V} = 375 \frac{\text{I. H. P.}}{V} \quad . . . \quad (1)$$

If the grate area be denoted by G, we have, taking the steam consumption at 21 pounds per I. H. P.

$$\frac{G \times C \times 9.3}{21} = \text{I. H. P.} \quad . \ . \ . \ . \ . \ . \quad (2)$$

substituting for I. H. P. in (1)

$$T = \frac{375 \times G \times C \times 9.3}{21\, V} = 166 \frac{G \times C}{V} \quad . . . \quad (3)$$

If H represents the heating surface, then (2) becomes

$$\frac{E \times H}{21} = \text{I. H. P.} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \quad (4)$$

E being as before the evaporation per square foot of heating surface per hour. Substituting (4) in (1) we get

$$T = \frac{375 \times E \times H}{21 \times V}$$

$$= \frac{375 \times 0.124\, C \times H}{21 \times V}$$

$$= 2.21 \frac{C \times H}{V} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (5)$$

By introducing a factor, say, .85, representing the mechanical efficiency of the locomotive, and assigning a suitable value to C, we shall obtain expressions giving the available tractive force at the rails. For instance, if the maximum coal consumption be put at 120 pounds per square foot of grate per hour, then

$$T_1 = 0.85\ T$$

$$= (0.85 \times 166 \times 120) \frac{G}{V}$$

$$T_1 \doteq 16{,}930 \frac{G}{V} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (6)$$

$$T_1 = (0.85 \times 2.21 \times 120) \frac{H}{V}$$

$$= 225 \frac{H}{V} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (7)$$

where T_1 is the available tractive force.

In order to find the load that can be hauled, divide the tractive force as given by the resistance per ton at the required speed, and the quotient will give the gross load in tons. By inverting V and T_1 as the total resistance of the train, we can determine the velocity that will be acquired. At low velocities the tractive force as found above may exceed the tractive force of the engine as found in the usual way; of course, the lower value should be taken.

As a numerical example let us take the case of an express engine working a train at a speed of 60 miles per hour on the level, and suppose that the engine has a grate area of 20 square feet, and that the weight of the engine and tender is 90 tons. Then, taking Eqn. (6), we have as the total tractive force

$$T = 16{,}930 \frac{G}{V} = \frac{16{,}930 \times 20}{60} = 5{,}643 \text{ lbs.}$$

At a speed of 60 miles per hour the resistance per ton is about 16 pounds.

$$\text{Hence the gross load } = \frac{5{,}643}{16} = 353 \text{ tons}$$

and the net load behind the tender will be $350 - 90 = 263$ tons approximately, equal to twenty six-wheeled vehicles. Such a load would probably be as much as an engine having 18-inch by 26-inch cylinders could manage, especially if a side wind was blowing.

The chief value of the big boiler lies in the fact that it carries so large a bulk of hot water that, should the steam pressure show a tendency to fall when nearing the top of a long bank, the feed can be shut off, thus temporarily increasing the boiler power by some 25 per cent., owing to the fact that the latent heat of evaporation only has to be supplied. With the modern big boiler some 3 or 4 miles can be run with the feed shut off without letting the water level drop dangerously low.

For a similar reason it is advisable not to sacrifice water space to heating surface in engines which have to stop and start frequently. Such engines generally need to accelerate the speed rapidly, and it is of great use to be able to hold the injector off until the speed has been attained and the boiler can be filled up as soon as steam is shut off, thus preventing the safety valves from lifting.

In conclusion, the writer would emphasize the fact that such calculations as the above must not be regarded as rigidly correct, as the conditions under which the locomotive works are continually changing. At the same time the numerical constants inserted in the formulæ given above are such as to give loads which are within the power of an engine under distinctly adverse circumstances.—*C. Hugh Sumner in the Engineering Review.*

INCREASING USE OF SUPERHEATERS

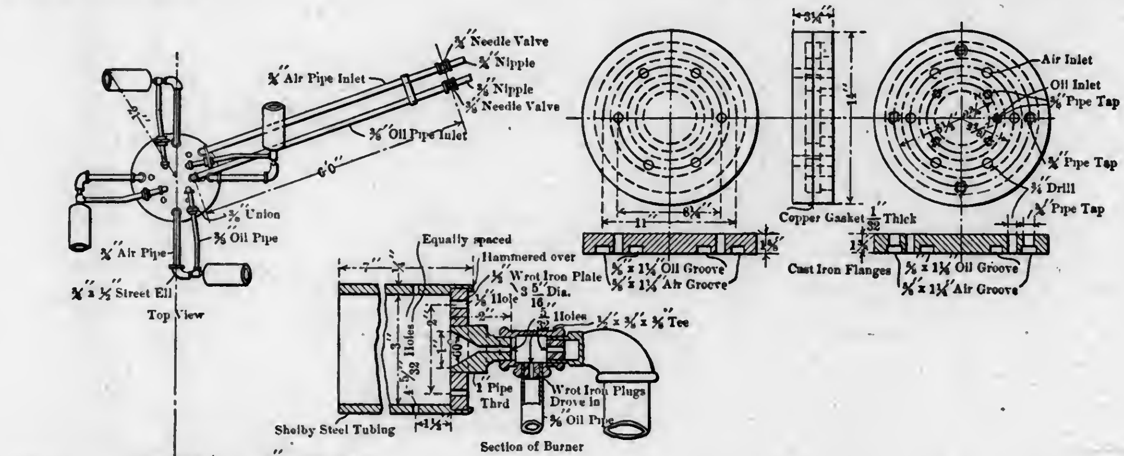
In 1901 the Canadian Pacific introduced the use of superheated steam on locomotives in America and nearly 500 Vaughan Horsey superheaters are now in service on that road. The Atchison, Topeka & Santa Fe, with 168 locomotives thus equipped, comes second in the list of twenty roads in this country now trying out a total of eight types of superheaters. The Schmidt superheater is used on 130 railroads in Europe, applied to over 5,000 engines. The adoption of superheaters in this country has, on the other hand, been along more conservative lines, notwithstanding the fact that nearly all the roads using them report a material saving in coal and at least half the number find no increased cost in running repairs. The most serious trouble experienced has been in leaky gaskets and filling of front end and flues with cinders.

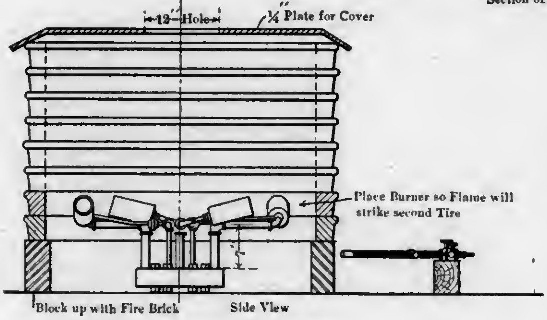
The question of the amount of superheat is a most important one. The Purdue tests have shown that the first 80 to 100 degrees superheat do not make the same proportional decrease in coal consumption as do the second 80 or 100 degrees. European practice is to superheat until the temperature is 500 to 600 degrees Fahrenheit or over, in fact, as high as possible, and still maintain good lubrication, with forced lubrication for the balanced piston valves. This general practice applies to simple and to compound locomotives; in both cases the attempt appears to be to prevent condensation in the cylinder. This makes an expensive construction to maintain, and it has not met with favor in this country.

THE ORDER OF THE HARRIMAN LINES for 196 freight locomotives to cost about $4,000,000, and which was placed with the Baldwin Locomotive Works in Philadelphia, has created much favorable comment and is looked upon as the beginning of more liberal equipment purchases on the part of the railroads. In itself it is one of the largest locomotive orders ever placed at one time and will keep the Baldwin plant busy for some time

AN EFFICIENT TIRE HEATER

The accompanying illustration shows the detail construction of an oil heater which has been constructed at the West Springfield shops. It has been installed on the floor of the shop, where the tires can be handled by the cranes, and in close proximity with the drawing wheel gang.





TIRE HEATER DETAILS.

It consists of a base built up of two plates properly grooved, to which are connected the air and oil pipes of four burners, as well as two supply pipes. These burners are of simple and efficient construction, which is clearly shown in the illustration. They give an intense heat and a very large flame, which will heat a bank of eight tires very rapidly.

AIR DRIVEN FLUE CUTTER AND ROLLER

A machine which will permit the cutting out of one flue per minute in the front end of a locomotive, requiring the services of but one man, is in use at the Readville shops, and is shown in the accompanying illustration.

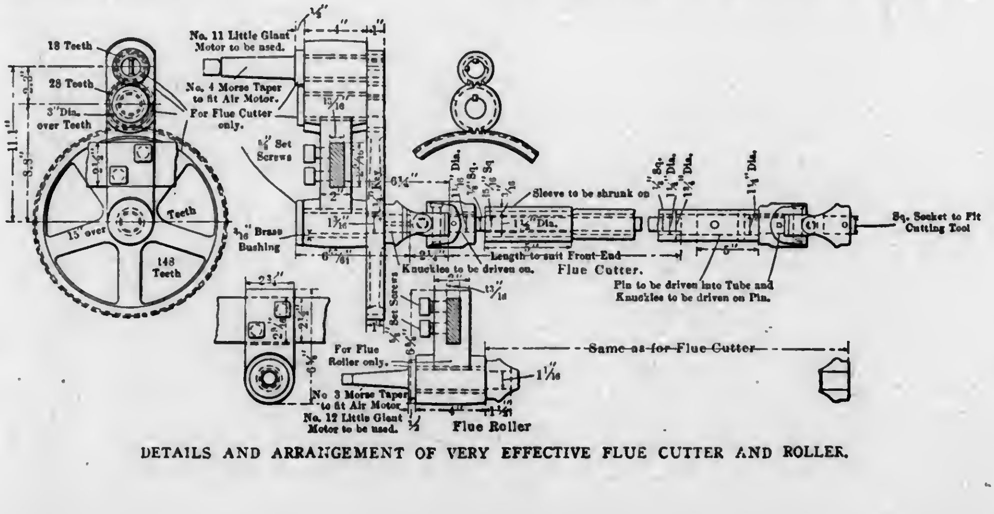
The apparatus is carried by a 2½ by ¾ in. bar about 78 in. long, which is provided with a number of ¾ in. holes in addition to a 10 in. slotted opening of the same width at one end. This bar is secured across the front end ring and carries the weight of the motor and gearing. Three gears are provided, the one connected to the motor having 18 teeth, which meshes with a 28 in. gear, which in turn meshes with a 148 tooth gear, each being a 1 in. face, giving a ratio of about 1 to 8½ revolutions between the cutter and the air motor.

On the large gear is a universal joint, which connects to a ⅞ in. square bar, that has a sliding connection with a long piece of tubing, the end of which is reduced and squared on the inside to 5/16 in. across the flats. This reduced end is 5 in. long and over it is shrunk a 3/16 in. sleeve. The tube is 1¾ in. outside diameter for the rest of its length, which is varied to suit the length of the front end and carries at its other end another universal joint, which in turn connects the flue cutter or roller. The ⅞ in. square bar is of considerable length and permits a variable extension to be obtained as desired.

For the flue roller the motor is connected directly to the first universal joint, a different holder being provided, as is shown in the illustration.

When this apparatus is arranged in the front end a small clamp is secured to the throttle of the air motor and the rod carried forward permits one man to either cut or roll the flues.

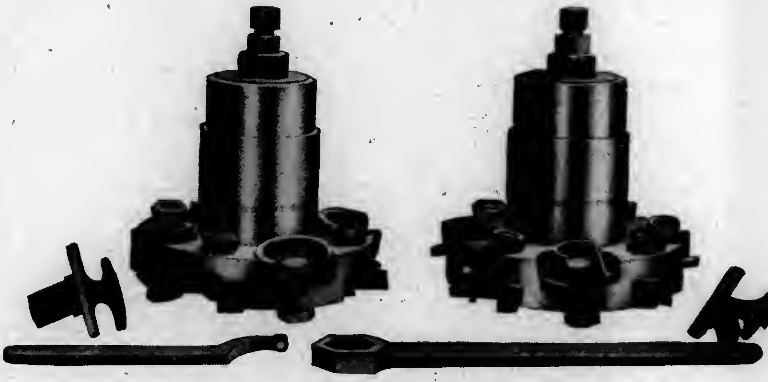
MOTIVE POWER FOR PANAMA CANAL.—Instead of the familiar old towpath mule giant electric locomotives will move the shipping through the Panama Canal locks. The ordinary locomotive would spin its wheels wildly and ineffectively upon the usual form of steel rail when its drawbar felt the weight of a twenty-thousand-ton warship, but the big electric locomotives will be geared to the tracks by a middle rail cut into the form of a rack giving enormous tractive power.



DETAILS AND ARRANGEMENT OF VERY EFFECTIVE FLUE CUTTER AND ROLLER.

A NEW CUTTER HEAD

The user of every high speed matcher is interested in the production of flooring at the lowest price consistent with good work. He feels the necessity of procuring tools and appliances that will not only do good work, but also such as will add convenience for the workmen, with genuine labor-saving advantages. Herewith is illustrated the "Shimer Limited" Cutter Head, manufactured by Samuel J. Shimer & Sons, Milton, Pa., the latest members of the large family of cutter heads on the market.



THE "SHIMER LIMITED" CUTTER HEADS.

In construction this head closely resembles the regular "Up-to-Date" and "Best of All" Cutter Heads which have been the standard tools for several years, but differs therefrom in the method of attaching them to the spindle; in the construction of the bit seats and of the bit designed for faster cutting; in the greater strength of the holding bolts, and especially in the self-centering device which clings to the spindle when drawn up, securing it firmly thereto. The spindle gripping device is positive and effective in its purpose of holding fast to the spindle, as also in centering the head for a more uniform action of the cutters. This is accomplished by having the central bore of the head tapered and having a rotatable cap and nut fitted in the upper portion. Into this bore a taper collet projects, having an upper threaded portion fitting the rotatable nut. When the top nut is drawn up the collet contracts and binds itself firmly to the spindle. This device is simple and effective and one not likely to get out of order.

To match flooring at the rate of 150 to 170 lineal feet per minute the side heads must be in perfect balance and the bits must be jointed. The foregoing description has shown that the heads are bound to be perfectly centered, and for the jointing the manufacturers provide a practical hand jointing machine. These heads are made either solid or with the expansion feature as may be preferred. All cutters are preferably made of high quality tool steel tempered to file. They hold an edge for any hard lumber for five hours and in many instances for a ten-hours' run.

THE VALUE OF AN APPRENTICESHIP.—There is nothing that will ever take the place of an apprenticeship. There is no trade school or training school in the country that will turn out young men or boys who are capable of entering a shop and competing with the average mechanic; while they may be taught considerable "book learning," their practical instruction must, of necessity, be limited. There is nothing that will take the place of practical experience. Manual training in our public schools may bring out the talent, may display the genius, but the fraternities and sororities of our high school system have made too many boys, who are natural born mechanics, "shun" the actual work, and dread the thought of an apprenticeship, it not being in keeping with the social and snobbish ideas gained from the fraternities and sororities while passing through high school.—*F. W. Thomas, Supervisor Apprentices, A., T. & S. F. Ry.*

VALUE IN FRONT END SPARKS

Considerable interest attached to the experience of the Prussian State Railway authorities in the utilization of the smoke-chamber waste from their locomotives. This waste consists of the particles of unconsumed fuel drawn by the strong draught from the fire-box through the tubes, and then deposited in the smoke box beneath the funnel. The product, which varies in size from a grain of sand to a hazelnut, is really hard coke, and was previously thrown on heaps to be sold at low prices for use in road construction. Attempts to employ it as fuel were not successful even when it was made into briquettes with tar, but very satisfactory results are now being obtained by distilling it, employing the gas so produced in gas engines and converting the power into electricity. The Prussian State Railway has already six plants working, and the other German railways are following suit. It is estimated that the Prussian railway system will obtain 160 million kilos of the waste coke annually, capable of generating 25,000 horsepower daily. The actual cost of the electricity—without allowing for depreciation and interest on capital outlay—is calculated at about three pfennigs, say one-third of a "penny" (two cents) per kilowatt-hour.

FREIGHT TRAIN RESISTANCE: ITS RELATION TO CAR WEIGHT, by Edward C. Schmidt, has just been issued as Bulletin No. 43 of the Engineering Experiment Station of the University of Illinois. This bulletin presents the results of tests made upon 32 freight trains in regular service, in order to determine their train resistance. These tests were undertaken to study the effects upon train resistance of both speed and the average weight of the cars composing the train. The results show the usually accepted influence of speed upon resistance, and they reveal a still greater influence of average car weight in effecting changes in resistance. For trains composed of care weighing 15 tons, on the average, the resistance is shown to vary from 7½ lb. per ton at 5 miles per hour to 13½ lb. per ton at 40 miles per hour; while for trains composed of cars weighing 75 tons, the resistance is shown to vary from 3 lb. per ton at 5 miles per hour to 5½ lb. per ton at 40 miles per hour. Copies of Bulletin No. 43 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

NEW SHOPS FOR THE BOSTON AND MAINE.—The general repair plant for which the Boston and Maine now is seeking a site will cost about $3,000,000 above the land and will employ several thousand men, with the possibility of still greater development in years to come. The buildings will be of the most approved fireproof construction and will be intended to take care of the bulk of the locomotive and car repair work on all of the Boston divisions, so for that reason it must be conveniently situated with reference to accessibility from Boston.

COLD SAW CUTTING OFF MACHINE

The constantly increasing demand for metal sawing or cutting machines and the value of equipment of this kind in all metal manufacturing plants, singularly enough does not appear to be realized by a great number of manufacturers. For instance, many plants have lathes in operation cutting up shafting, bar stock, gear blanks and the still slower method of slotting flats, such as locomotive rods, valve gears, etc.

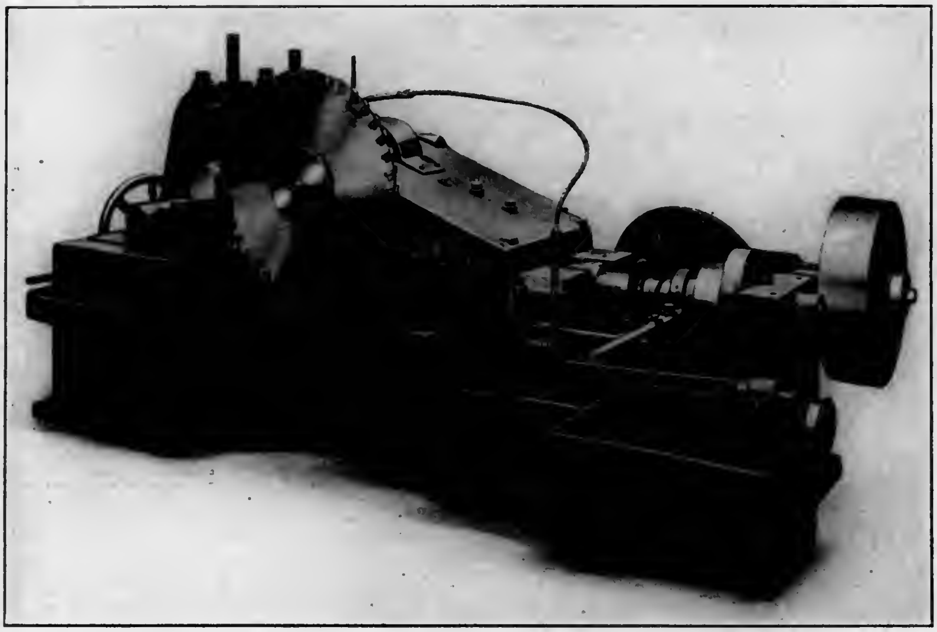
The Newton Machine Tool Works, Inc., of Philadelphia, Pa., has devoted considerable study to the development of this appliance, and in their new design herein illustrated have produced a machine with which feeds are now obtained equal to five times that obtained by the old design of machines. In their time these latter were amply heavy to drive the solid tooth blades then used to their maximum efficiency. However, with the introduction of high speed cutting steels, and their incorporation in cold sawing equipment, the blades now being known as inserted tooth high speed saw blades, the advantages in high productive capacity of cold sawing machines was quickly realized. For instance, a 12 in. square billet of .70 carbon was cut off in 10 minutes, and an 8½ in. diameter round billet of .45 carbon was cut off in 6½ minutes. Two rod cuts have been made with the new machine 12 in. deep with the rod 5 in. thick, and the time of cutting only 17 minutes. While this is slightly excessive, many forges are obtaining feeds of from ¾ in. to 1 in. per minute on a large proportion of their output. These cuts referred to are not, however, presented as speed tests, but to demonstrate the steady, even motion of the best obtainable, or inserted tooth saw blades, when used on Newton machines.

In the construction of the modern machines to obtain this output only the best of materials, the most accurate fitting in construction, and the heaviest and well braced castings are used. There is only one important bracket on the machine, and this carries with the bearings for both of the only two shafts that have opposed stresses. The design of every machine must adhere to specifications similar to the following:

Spindles finished by grinding, fitted to the saddle by hand scraping, and the pinion driving the spindle gear to have the teeth cut from the solid shaft. The spindle to revolve in capped bearings, to compensate for wear, to be supported at both ends and to be equal in length over all to the diameter of the saw blade, and the driving gear to be mounted between the end brackets. The worm wheel shaft, from which the teeth of the driving pinion are cut, carries a solid bronze worm wheel with teeth of steep lead, the angle calculated to operate with the minimum amount of power lost through friction, which is actually less than spur gear driven machines on account of a few connections. The driving worm to be hardened and fitted with roller thrust bearings, both these and the worm wheel to be encased for continual lubrication, and the horizontal driving shaft to have a bearing on each side of the driving worm. The bearings for the worm wheel and driving worm shafts to be cast solid with the saddle in order that all stresses may be self-composed, and all bearings to be bushed where necessary. The machine to have constant friction feed, variable in rate, with power quick return and hand adjustment.

All operating levers to be placed conveniently to facilitate the maximum output by decreasing the idle time of the machine, and the feed screw to have a bearing at both ends to permit of this always being maintained in tension. The spindle saddles to be of heavy boxed type construction, to have a bearing the full width and full length of the saddle on the bed of the machine, with underlocking gibs cast solid and adjustments made by means of taper shoes and square sheer bearings on the saw side. The saddle to be fitted to the sheers by hand scraping and to be fitted with dogs for tripping the positive safety release for each of the extreme positions of the saddle, and also the adjustable automatic release to the feed, and in order to facilitate the operations on broad or angular work, the hand wheel to be fitted on the squared end of the adjusting screw. The base of the machine is one solid casting and comprises the bearings for the saddle and the supports for the driving mechanism in addition to the work table which has "T" slots cut from the solid, and the pans for the lubricating system are also cast solid. The base and outer bracket to have finished pads to permit of changing the machine from belt to direct motor drive by simply bolting on the motor bracket, as the attaching faces are finished before shipping the machine, whether the machine is sold for belt or motor drive, and all machines to be furnished complete with pump, piping and attachments for lubrication, as experience has proven that to be effective all heat-absorbing and lubricating materials must be delivered at the point of cuting. Especially is this true on the inserted high speed saw blades.

This design of machine is practically self-contained. It occupies little floor space, and on account of the few parts used and the attention to the best combinations of metal for the transmitting gears, a very low maintenance cost is obtained, especially in saw blades, as there is no jar or chatter to the drive, and any



POWERFUL NEWTON METAL SAW.

unequal pressures are gradually taken up by the angle of the worm and worm wheel.

At the time of designing the older type of machine a cold saw cutting off machine was thought to be of a very rough nature, to be operated by unskilled help, and while the present type of machine requires no skill for its operation on account of its simplicity, much better results can be obtained by operators having at least some knowledge of mechanics, as one so familiar pays better attention to securely clamping the work, a neglect of which causes 80 per cent. of the complaints on equipment of this description. The chief consideration of the development of these machines is based on the fact that a cold saw to-day is a machine tool on which the sawing is in reality a milling operation, and operates under considerations much more delicate than encountered in the operation of the horizontal or knee type milling machine on account of the large diameter and necessarily narrow width of the blades.

COLBURN HEAVY DUTY DRILL PRESS

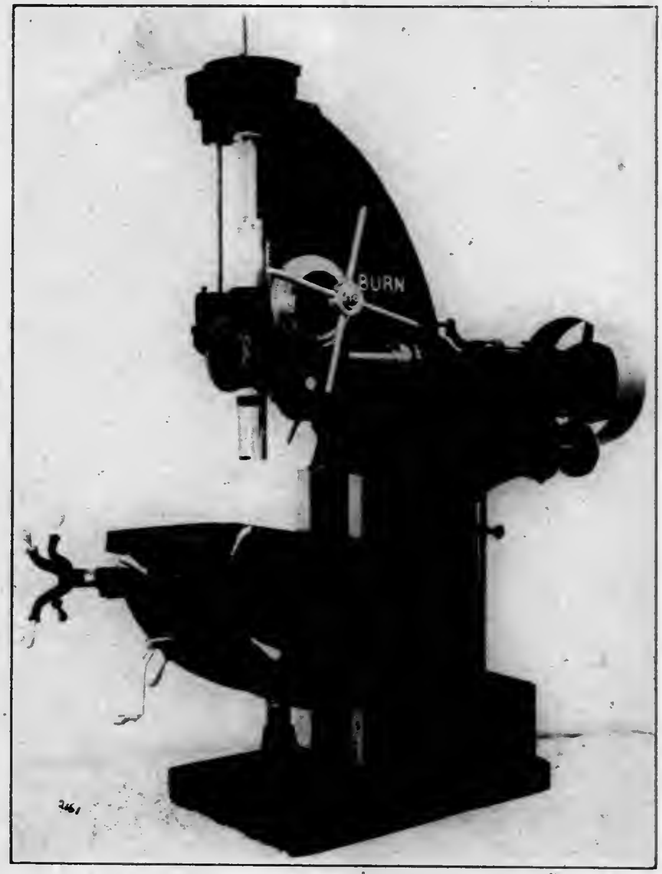
It is a well-known fact in connection with the general development of machine tools which has been a prominent feature of recent years that the faithful and indispensable drill press was probably the last to receive attention. The drill presses of only twenty years ago were crude and unsatisfying, that is, at least so far as confined to railroad shops. They were not designed to meet the equal requirements of strength and rigidity within reasonable compactness, and they either embodied an unwarranted overplus of stock, or such a lack of it as to prevent anything like a wide operating range.

No greater contrast can be afforded than in the comparison of this useful machine in its modern form with the many makeshifts of the past. This 24-inch heavy duty drill press by the Colburn Machine Tool Co., Franklin, Pa., well illustrates the attention which is now being given the appliance and the high development to which it has attained. The drill press properly understood has ceased being merely a machine for drilling holes and has come to be recognized as a productive tool of much importance.

The effective arrangement of detail in the drill press herein illustrated is particularly pleasing. No cast iron gears whatever are used in the machine, all being made of steel forgings or manganese bronze castings, and all gears in the speed box and feed box run in a bath of oil. The main driving gears on the spindle are helical, and can be driven at a much greater speed than spur gears with the elimination of any tendency to chatter. The spindle is of forged high carbon steel, with the thrust taken on Hess-Bright ball thrust bearings which withstand the most severe duty without injury. The spindle has a travel of 16 inches, and has a No. 5 Morse taper at the bottom.

Feed changes are obtained through positive gears running in an oil-tight box, the changes being made by means of a drive key and back gears. The feeds are six in number, varying in geometrical progression from .009 to .060 per revolution of the spindle. Direct feed on the spindle is through a large diameter worm gear carrying a graduated dial reading in thirty-seconds of an inch that enables the operator to accurately measure the depth drilled. This dial is provided with an adjustable pawl which can be set to automatically trip the feed at any point up to 14 inches travel of the spindle. The feed may also be tripped by hand from the operator's position. All the gears in the feed box run in a bath of oil and all bearings have positive lubrication.

The compound table, shown with the machine illustrated, is furnished only when specially ordered and is probably the most interesting feature in connection with this handsome and exceptionally well designed drill press. It is not an attachment to the regular table, but consists of a special knee with a table having a rapid movement through spiral worm and rack of 20 inches longitudinally, and 8 in. crosswise. Capstan handles are so arranged that the operator standing directly in front of the machine can manipulate the table in both directions without moving from his position. So rapidly can these adjustments be made that the drill will reach any point within the area of the table surface in less time than it takes to adjust the ordinary round drill press table. It is impossible for this compound table to spring in the slightest degree, as the massive knee and telescopic screw effectually resists this tendency. A large oil pocket is cast on each side of the table, and a cored opening running entirely through the table drains the lubricant from the



HEAVY DUTY DRILL PRESS.

left to the right hand jacket and from here it is piped through a flexible tube back to the tank. The working surface of the compound table is 16 by 30 in.

The drive consists of an oil-tight box containing all the gearing from which the spindle speeds are obtained, and is driven by a single friction clutch pulley, and no countershaft is required. All speed changes are made by two levers at the front of the machine. This machine has a capacity to the full cutting edge of 2½ in. high speed drills in solid steel. Its net weight with plain table is 4,000 lbs., and with compound table, 4,400 lbs.

A NEW WHITE METAL ALLOY called "Atherium" has recently been brought out, for which the following properties are claimed: It is lighter than aluminum, the specific gravity being 2.4 to 2.57, according to the mixture. The alloy has a tensile strength of 18.66 tons per sq. in. A test made by R. H. Harry Stanger, of Westminster, on a test piece of 0.628 in. in diameter showed an elastic limit of 33,712 lb. per sq. in., and an ultimate strength of 41,798 lb. per sq. in. The extension in 2 in. was 17.5 per cent., and the reduction of area was 39.1 per cent. The alloy makes good sound castings, and works well in rolling and turning. Clean screw threads can be cut, and it can also be soldered, forged and welded. It does not tarnish or corrode, and withstands the action of sea-water. It is also electrically positive; the conductivity is about 55.1.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Feb. 7	The Generation and Distribution of Electric Power and Its Application to Railroads	Z. Darlington	Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	Mar. 10			H. D. Vought	95 Liberty St., New York
New England	Feb. 14	Impressions of English Railway Service	W. J. Cunningham	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Feb. 17	The Application of the Wireless Telegraph as an Aid in the Operation of Railroads	F. H. Milliner	H. D. Vought	95 Liberty St., New York
Northern	Feb. 25			C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Feb. 24	The Conservation of Human Life in Steam and Electric Railroad Travel	G. P. Thurber	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Feb. 13			F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	Apr. 20			A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Feb. 10			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	Feb. 21				390 Old Colony Bldg., Chicago
Western Canada	Feb. 13			W. H. Rosevear	199 Chestnut St., Winnepeg, Man.

THE EVOLUTION OF AIR BRAKES MADE NECESSARY TO MEET MODERN TRAIN CONDITIONS

NEW ENGLAND RAILROAD CLUB.

H. N. Lamb, mechanical instructor, railway department, of the International Correspondence Schools, Scranton, Pa., presented at the December meeting of the above club a very interesting paper on the development of the air brake, and its further possibilities. Mr. Lamb points out forcibly that the installation, care and maintenance of the air brake is of greater importance than some roads seem to regard it, and, though vast sums of money may be spent in purchasing the best equipment and applying the same to locomotives and cars, yet the efficiency of the brake will not be maintained unless the brake itself is maintained, and this can only be properly done by a thorough organization of the air brake department of the railroad under the supervision of competent and up-to-date men.

Those who are of an inventive turn of mind will find plenty of food for thought in the future development of the air brake to more properly meet the conditions of to-day. The author claims that the present brake, efficacious as it undoubtedly is, has not yet reached perfection; that it cannot be said there is nothing more to be accomplished along these lines, as to-day a brake is needed with the following features not possessed by the present equipment:

First, a brake that will automatically increase the braking power of a car in proportion to its loaded weight; second, a cheap and practical coupling for air brake hose or pipe that will couple and uncouple without damage when the train breaks in two; third, a practicable brake for freight cars capable of being gradually released; fourth, some signal or means through which an engineer can ascertain if all brakes in his train have released; fifth, a practical brake for freight cars whose efficiency will not be affected through cylinder leakage; and sixth, a brake which will quickly recharge, thereby eliminating the use of retainers.

This paper in general may be regarded as an extremely valuable addition to air brake literature. It is well written and will well repay an attentive perusal.

LUBRICATION OF HIGH PRESSURE SLIDE AND PISTON VALVE LOCOMOTIVES

CENTRAL RAILWAY CLUB.

This always interesting subject was accorded a decidedly novel treatment in a short, but none the less instructive paper, presented by W. O. Taylor before the above club at its January meeting. In the premises the author contends that, despite opinions to the contrary, if the lubricant is properly introduced and distributed with the steam the pressure and temperature of the steam are factors of but little importance. To this end it is advocated that the oil be delivered into the steam at a point where it can be thoroughly intermingled with the steam before the latter reaches the steam chest or valve chamber, and through the thorough lubrication of the steam secure similar lubrication for every point with which it comes in contact.

Mr. Taylor said that it has been demonstrated beyond question that the cylinder oil in general use is efficient under all steam pressures and temperatures yet obtained in locomotive operation, and that it has been further demonstrated that locomotives using superheated steam, where the maximum temperature does not exceed 500 degrees F., do not require any more oil for valve and cylinder lubrication than the same locomotive using saturated steam. It is further claimed that conditions are more favorable for satisfactory and economical lubrication when superheated steam is used and that less oil is required. The absolutely dry condition of the steam entirely obviates the flushing of valves and cylinders with the consequent washing away of the lubricant. The paper concludes with several interesting references to actual service performances in support of the author's contentions.

CHRISTMAS ENTERTAINMENT

NEW YORK RAILROAD CLUB.

The December meeting of this club was devoid of the usual paper, but it was none the less an enjoyable occasion to a formidable array of members and their guests who journeyed from far and near to attend what has in reality come to be considered as a general annual reunion. The feature of the short session was the presentation to W. G. Besler, the retiring president, of a handsome silver pitcher, after which an adjournment became in order to the large auditorium of the Engineering Societies Building where the usual liberal vaudeville entertainment was provided. An elaborate supper terminated the thoroughly enjoyable evening.

SOME PERTINENT FEATURES RELATING TO GAS POWER

RAILWAY CLUB OF PITTSBURGH.

At the November meeting of this club an able paper on the above subject was presented by Edwin D. Dreyfus, commercial engineer of the Westinghouse Machine Co., Pittsburgh. In the admitted breadth of this important subject it has been impossible to give due emphasis to the variety of factors and conditions that individually are deserving of lengthy discussion. The author has endeavored, however, for the benefit of the club members before whom it was read, who have not in any way identified themselves heretofore with this phase of engineering, to direct their attention to its fundamental features without introducing complex or elaborate theory and descriptions.

BOOK NOTES

The Practical Engineer Pocket Book and Diary for 1911. Published by the Technical Publishing Co., Limited, 55 and 56 Chancery Lane, London, W. C. 702 pages, 3½ x 5½. Illustrated. Price, 36c.

The demand during 1910 for The Practical Engineer Pocket Book is said to have eclipsed all past records, the book being dispatched to every part of the world. Although much obsolete and less important matter has been stricken from past editions, the book now before us contains over 700 pages of matter which has been most carefully selected in order to present a book having the maximum of utility. The new matter includes Notes on Stoker Systems, Calorimeters, Fuel Economisers, Thermal Storage, Superheaters, Bearing Pressures, Recent Practice in Ball and Roller Bearings, Cup Leathers, Chain Drivings, the Magnetic Clutch; also Pyrometry, Pneumatic Tools and the Extensometer; Tables of Flange Dimensions, Pinion and Music Wire, Zinc and Lead Gauges, Solders and Alloys. Revisions have been very extensive, and affect such articles as Accurate Gauging in the Shop, Pattern Allowances for Machinery, Belt Factors, Gas and Oil Engine Ignition and Tests, Water Turbines, etc., etc. The book is fully indexed and contains a diary of 64 pages.

Railway Management at Stations. By E. B. Iratts. Cloth, 605 pages, 5 x 8 inches. Published by McCorquodale & Co., Ltd., Cardington St., Eaton Square, London, N. W. Price, $2.50, of Van Nostrand Co., New York, N. Y.

This book, which is now passing through the fifth edition, has been in circulation for over 20 years, and by its continued sales appears to have met an appreciative demand in this country, although its scope is necessarily confined to British practice. It deals most comprehensively with station work and management, reviewing in detail the features of organization, discipline, canvassing for traffic, acceptance and delivery of goods, accounts and legal claims. Mr. Iratts' long experience as goods or freight manager of the Midland Great Western Railway qualified him to discuss these important questions from an authoritative standpoint, therefore the book becomes of exceptional value for reference in the interpretation of many puzzling details which continually arise in connection with such work. The chapters on the arrival and departure of passengers and the handling of parcels and baggage are very interesting, despite their foreign setting, and the fact that only a very large terminal is under dissection. The book also contains sections of acts of parliament in relation to railroads which are very conveniently arranged for reference. Not the least interesting feature in connection with this valuable work is an extensive glossary of railway terms in which the different nomenclature between that country and our own for the same object or operation is forcefully illustrated.

Proceedings of the Master Car Builders' Association. Forty-fourth Annual Convention. Atlantic City, N. J., June 15 to 17. Published by the Association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

The subjects reported upon and discussed at this convention were of unusual importance, and their compilation in detail as herein presented renders this report a most valuable addition to the forty-three volumes which have preceded it during the life of this association. Among some of these reports might be mentioned that of the standing committee on the Revision of Standards and Recommended Practice; Train Brake and Signal Equipment, constituting a thorough résumé of emergency brake tests made on the Lake Shore and Michigan Southern Ry. during October, November and December, 1909. In addition to its usual duty of investigating the properties of brake shoes the standing committee on brake shoe tests considered in its report, at the request of the executive committee of the association the standards applying to brake beams. No doubt at this time interest principally centers in the report of the committee on the consolidation of the two associations, and accompanying its report is the constitution of the proposed "American Railway Mechanical Association." The present report of the forty-fourth convention contains 849 pages, with the usual addition of many folding diagrams of M. C. B. standards.

Proceedings of the American Railway Master Mechanics Association. Forty-third Annual Convention, Atlantic City, N. J., June 20 to 22, 1910. Published by the Association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago, Ill.

The full report of the committees and the discussions thereon are given in this volume of 600 pages. Very valuable reports were given on the following subjects: Mechanical Stokers; Education as an Essential of Fuel Economy; Superheaters; Locomotive Frame Construction; Freight Train Resistance; Train Brake and Signal Equipment; Design, Construction and Inspection of Locomotive Boilers; Locomotive and Shop Operating Costs, and on Consolidation.

Proceedings of the Traveling Engineers' Association. Eighteenth Annual Convention, held at Niagara Falls, Canada, August, 1910. Leather, 392 pages, 6 x 9. Secretary W. O. Thompson, 820 Elmwood avenue, Buffalo, N. Y.

There is not a dull line in this admirably prepared and well-edited convention report, and a careful perusal of its pages must interest anyone in the locomotive world, irrespective of his position either on the road or in the shops. The Traveling Engineers are to be congratulated on the real value of the subjects selected for their conventions, and too much praise cannot be given for the able manner in which the various papers are prepared and presented. The paper on Superheat As Applied to Locomotives provoked a most instructive discussion in view of the timeliness of the subject. It covers some 90 pages of the report and constitutes a thorough review of what has been accomplished in superheating up to the present time. Fuel Economy was not lacking in equal interest, and was well discussed. There were other papers of great value, and on the whole it may be said that their compilation in this form constitutes a valuable addition to existing locomotive data.

Pocket-Book of Mechanical Engineering. By Charles M. Sames, B.Sc. Flexible leather, 4 x 6⅝ in. 220 pages. Illustrated. Published by Charles M. Sames. Price, $2.00.

This book is the result of the writer's endeavor to compact the greater part of the reference information usually required by mechanical engineers and students into a volume whose dimensions permit of its being carried in the pocket without inconvenience. It is a correct and up-to-date digest of mechanical engineering science, embracing the widest range of subject matter, and of exceptional value to designers of machinery, containing one of the most comprehensive collections of formulas, data and constants relating to the proportioning of machine parts, assembled machines and motors that is published in the English language.

The Westinghouse Diary for 1911. Published by the Westinghouse Electric and Manufacturing Co., Pittsburg, Pa. 96 pages, 2½ x 5.

This little book has made its welcome appearance replete with the usual tables and valuable reference matter which are indispensable to the engineer, and, in fact, to anyone directly or indirectly interested in the application of electricity. The portion devoted to the annual record or diary consists of 50 pages, followed by several pages for addresses and memoranda. An unique feature is the presence in the book of some 16 pages ruled as expense account forms.

PERSONALS

C. H. DOEBLER has been made master mechanic of the Chesapeake & Ohio at Peru, Ind.

CARL HILL has resigned as master mechanic of the Fitzgerald, Ocilla & Broxton Railroad.

E. S. EDEN has been appointed master mechanic of the Central New England Ry., with office at Hartford, Conn.

F. W. RHUARK has been appointed master mechanic of the Baltimore & Ohio R. R., with office at Lorain, Ohio.

J. E. HENSHAW has been made superintendent of the Frisco shops at Springfield, Mo., vice G. W. Lillie, resigned.

C. N. SWANSON has been appointed superintendent of the car shops at Topeka, Kan., Atchison, Topeka & Santa Fe Ry.

H. HONDSEA has been appointed assistant master mechanic of the St. Louis & San Francisco R. R., with office at Memphis, Tenn.

J. DUGUID has been appointed master mechanic of the Grand Trunk Ry. at Montreal, Que., to succeed J. C. Garden, transferred.

D. H. SPEAKMAN has been appointed master mechanic of the Baltimore & Ohio R. R. at Benwood, W. Va. He succeeds A. Schaaf.

WILLIAM MYERS has been made assistant roundhouse foreman of the Atchison, Topeka & Santa Fe Ry. at Fort Madison, Iowa.

WALTER REID has been made road foreman of engines of the Santa Fe Ry. at San Bernardino, Cal., vice M. P. Cheney, promoted.

J. B. NEISH has been appointed master mechanic on the Northern Pacific R. R. at Minneapolis, Minn., succeeding Silas Zwight, transferred.

FRED VON BERGEN has been appointed air brake inspector of the Nashville, Chattanooga & St. Louis Ry., succeeding Otto Best, resigned.

H. A. SOUTHWORTH, division foreman on the Maine Central R. R. at Waterville, Me., has been appointed master mechanic at Portland, Me

C. D. LIDE has been appointed master mechanic of the Georgia, Florida & Alabama Ry., with office at Bainbridge, Ga., succeeding J. D. Crawley.

R. COLLETT has been appointed superintendent of locomotive and fuel service of the St. Louis & San Francisco R. R., with office at St. Louis, Mo.

F. T. SLAYTON has been made superintendent of motive power of the Virginia Ry., with office at Princeton, Va., succeeding L. B. Rhodes, resigned.

SILAS ZWIGHT, master mechanic at Minneapolis, Minn., Northern Pacific R. R., has been transferred to Missoula, Mont., succeeding T. J. Cutler, resigned.

O. M. KNECHT has been appointed roundhouse foreman at Las Vegas, N. M., Atchison, Topeka & Santa Fe Ry., succeeding E. J. McMahon, transferred.

J. I. HALLER has been transferred from general roundhouse foreman, Susquehanna shop, Erie Railroad, to general foreman at the same point, vice L. R. Laizure, promoted.

H. M. BARR has been appointed master mechanic of the Sterling division of the Chicago, Burlington & Quincy Railroad, at Sterling, Colo., vice T. J. Raycroft, transferred.

G. C. BONEFELD has been appointed master mechanic of the United Railways of Havana, at Havana, Cuba, vice William M. Stokes, resigned to go to the Galena Oil Co. at Buenos Ayres.

WM. LEID, locomotive engineer of the Buffalo division, Erie Railroad, has been appointed road foreman of engines, with headquarters at Buffalo, N. Y., succeeding Charles Davis, deceased.

J. C. GARDEN, master mechanic of the Eastern division of the Grand Trunk Ry., at Montreal, Que., has been transferred to the Battle Creek, Mich., shops, vice J. T. McGrath, resigned.

W. J. MCGEE, master mechanic of the Tampa Northern R. R., at Tampa, Fla., has been appointed master mechanic of the International & Great Northern R. R., with office at Mart, Texas.

D. J. SULLIVAN has been transferred from assistant general foreman at Susquehanna shop, Erie Railroad, to general roundhouse foreman at the same point, succeeding J. I. Haller, promoted.

C. W. FROMM has resigned as foreman of the Chicago, Indiana & Southern R. R. at Kankakee, and has been made roundhouse foreman of the Chicago Great Western Ry. at Clarion, Iowa.

J. W. CYR, division master mechanic at Hannibal, Mo., on the Chicago, Burlington & Quincy R. R., has been appointed superintendent of motive power at Chicago, succeeding Mr. Torrey, promoted.

O. J. KELLY succeeds H. D. Van Valin as a master mechanic of the Baltimore & Ohio R. R. at Parkersburg, W. Va. He was formerly night roundhouse foreman at Susquenanna, Pa., on the Erie R. R.

W. A. HAMMEL has been appointed purchasing agent of the Atlanta, Birmingham & Atlantic Ry., with office at Atlanta, Ga., succeeding W. D. Knott, granted leave of absence on account of ill health.

T. J. RAYCROFT has been appointed master mechanic of the Alliance division of the Chicago, Burlington & Quincy R. R., with headquarters at Alliance, Neb., vice F. C. Stuby, assigned to other duties.

A. G. MCCLELLAN, formerly general foreman of the shops of the Grand Trunk Ry. at Battle Creek, Mich., has been made road master mechanic, a newly created office, on the Chicago & Alton R. R., with office at Bloomington, Ill.

T. J. POWELL, formerly tool foreman of the El Paso & Southwestern Ry., and the first president of the American Railway Tool Foremen's Association, is now foreman of the railroad shops of the Chino Copper Company, Santa Rita, N. M.

T. J. CUTLER, formerly master mechanic on the Rocky Mountain division of the Northern Pacific R. R. at Missoula, Mont., has been appointed master mechanic on the Idaho division, with office at Spokane, Wash., succeeding F. B. Childs, deceased.

OTTO BEST has resigned his position as air brake inspector of the Nashville, Chattanooga & St. Louis Railway, to enter the supply business. He has accepted a position with the Nathan Manufacturing Company of New York, and his headquarters will be in that city.

F. A. TORREY, superintendent of motive power of the Chicago, Burlington & Quincy lines east of the Missouri River, at Chicago, has been appointed general superintendent of motive power of the entire Burlington system, with office at Chicago, succeeding F. H. Clark, resigned to go to the Baltimore & Ohio.

DAVID VAN RIPER, until recently master mechanic of the Rochester division, Erie Railroad, with office at Avon, N. Y., died recently at his home in Meadville, Pa. Mr. Van Riper had risen from apprentice to master mechanic on the Erie, and had a full knowledge of the latter important branch of railroad service. Some months ago failing health compelled his retirement from the exacting duties of the position, and he was assigned to lighter work at Meadville.

L. S. CARROLL, purchasing agent of the Chicago & North Western R. R., has been appointed general purchasing agent of the North Western and the Chicago, St. Paul, Minneapolis & Omaha R. R., at Chicago, a new office, and his former title has been abolished. John Ball has been appointed assistant purchasing agent, with office at Chicago. Isaac Seddon, purchasing agent of the Chicago, St. Paul, Minneapolis & Omaha R. R., at St. Paul, Minn., retains his office and title and will report to Mr. Carroll.

CATALOGS.

"TURRET LATHE EXPERIENCE" is the title of a leaflet issued by the Gisholt Machine Co., of Madison, Wis., in which some interesting operations are illustrated of work performed in the Gisholt machines.

SINGLE PHASE INDUCTION MOTORS.—Bulletin No. 3141, issued by the Emerson Electric Mfg. Co., of St. Louis, Mo., is devoted to a description of the Type 7142 F. A. single phase induction motor of from 1/10 to 1/6 horsepower.

AIR COMPRESSORS.—The Ingersoll-Rand class A-1 compressor forms the subject of a pamphlet issued by that company from its office, at 11 Broadway, N. Y., which describes the compressor in detail and illustrates all of its principal parts.

"ELECTRIC AIR" ROCK DRILLS.—Under this title the Ingersoll-Rand Co. of 11 Broadway, N. Y., has issued an attractive little treatise of 24 pages, illustrating the range of work for which the Temple-Ingersoll "Electric Air" drill is particularly adapted. The apparatus is fully described with the assistance of many fine half-tone cuts.

Laboratory Lathes.—These interesting appliances are thoroughly described and illustrated in Bulletin 3708, issued by the Emerson Electric Mfg. Co., of St. Louis, Mo. The bulletin is of especial interest to the users of these tools, and the substantial design of the latter is quite appealing, in view of the fact that it is a point often lost sight of in the majority of foreign tools for similar purposes.

Spiral Riveted Pressure Pipe.—The American Steel Pipe Works, of Chicago, Ill., has issued a pamphlet showing a number of views of long lines of Taylor's spiral riveted pressure pipe, as applied in various mining and pumping installations. This pipe for a number of years has been standard for exhaust steam purposes, and is also especially adapted for water supply lines, suction and discharge, etc.

Leather Belting.—The December, 1910, issue of *Phoenix*, published by the New York Leather Belting Co., 51 Beekman St., New York, has for its two middle facing pages some 20 finely executed half-tones of the principal members of its energetic and efficient staff. The design and arrangement of the cuts is clever and the general appearance decidedly attractive. The *Phoenix* also contains its usual amount of valuable information for belt users, and is on the whole an artistic and valuable issue.

Boiler-Makers' Tools.—Under this title the J. Faessler Mfg. Co., of Moberly, Mo., has just issued a very complete 32-page catalog of boiler-makers' tools, all of which are illustrated and their various advantageous features clearly indicated. Considerable space in the book is devoted to roller and sectional expanders, and much valuable information is embodied. The Faessler flue cutting machine for locomotive boilers is of special interest, and in a very finely executed cut it is shown applied to a locomotive and ready for business. The prominence accorded the general question of boiler maintenance at this time renders a study of this catalog of particular interest.

Ball Bearings.—This interesting subject has been dealt with at length by the Hess-Bright Mfg. Co., of Philadelphia, in one of the handsomest and most comprehensive catalogs which has reached this office in many months. The work, as it can scarcely be designated by any other name, is in reality an engineering treatise on ball bearings, and constitutes the last word on the subject. The historical matter in connection is of the highest value, and reflects great credit to the painstaking work of the compilers in bringing to light such a wealth of interesting detail. The book contains 64 pages, 9 x 12 inches, and is profusely illustrated, several hundred superb cuts being embodied in the text. For reference, especially, and for general information on its theme it is unequalled by any book in the language.

Seamless Steel Tubing.—The National Tube Co., of Pittsburg, Pa., has devised a most effective and unique method of illustrating the above mentioned product. It consists of a large framed table, a reproduction of that shown at the St. Louis Exposition and at the various mechanical conventions, and which attracted much attention. The table, which is composed of hundreds of tubing sections, graphically illustrates the large variety of shapes into which the Shelby Seamless Steel Tubing can be formed. The pieces of tubing illustrated were not made for this specific purpose, but were taken from parts of tubing made to customers' orders. The design, which is handsomely framed, is encircled by some beautiful examples of workmanship, including watch charms and paper cutters. On the whole it is a decidedly novel and attractive method of advertising.

Locomotive Valve Gear.—The Baker-Pilliod locomotive valve gear, manufactured by the Pilliod Co., 30 Church street, New York, N. Y., is now known as the Baker Locomotive Valve Gear, and its functions are well described in a new catalog just issued by that firm. The important facts only are presented, and it is quite evident from a perusal of its pages that every effort has been made to state them as clearly and concisely as possible. The catalog is handsomely illustrated with halftones of several locomotives to which the gear has been applied, and it is thoroughly descriptive of the improvements which have been made in the motion since its advent into the railroad field. The latter portion of the catalog deals with break-downs, and very valuable suggestions are offered as to the proper course to be pursued in the event of failure of any part of the gear. The catalog is in most attractive form and will well repay an attentive examination.

Electric Motors and Appliances.—The General Electric Company, of Schenectady, N. Y., has just issued several valuable bulletins descriptive of its varied output. The bulletin on voltage regulators has been revised and it illustrates and describes regulators for controlling the generator voltage and also those for regulating the feeder voltage. There are also reproductions of curves showing voltage with and without regulators installed. Bulletin 4784 is devoted to electric drive in pulp and paper mills. The advantages to be derived from the use of electric power in this industry are set forth, and a number of important installations are illustrated and described. Other bulletins which have been received from the same firm deal with direct connected generating sets; portable and stationary air compressor sets; electric drive in woodworking plants; small plane alternating current switchboard panels; belt driven alternators, and General Electric straight air brake equipments. Bulletin 4808 is of special interest as it deals comprehensively with the electrical equipment of the high speed electric railway connecting Washington, D. C., with Baltimore, Md. This publication is of general interest to railroad men.

NOTES

Ralston Steel Car Co.—This company, of Columbus, O., has increased its capital stock from $1,000,000 to $2,500,000.

Davenport Locomotive Works.—This company, of Davenport, Iowa, announces the opening of an office at 30 Church street, New York, N. Y., in charge of H. T. Armstrong.

Locomotive Superheater Co.—This company announces the election of George L. Bourne as its second Vice-President, with headquarters in the People's Gas Building, Chicago, Ill.

Niles-Bement Pond Co.—Effective January 1st, W. R. Lathrop assumed charge of the Birmingham sales office of the above company, and of the Pratt & Whitney Co., succeeding N. C. Walpole, resigned.

American Brake Shoe and Foundry Co.—This company, of Mahwah, N. J., has taken out a building permit to construct a one-story brick factory to cost $30,000 at 4500-4510 West Twenty-sixth street, Chicago.

Standard Coupler Co.—At the annual meeting of this company the present directors were re-elected. Although no official figures of the earnings are given out, it is said that they were the largest in the history of the company, and that plants are operating at practically full capacity.

Smith Locomotive Adjustable Hub Plate Co.—This company of Pittsburg, Kan., announces that its hub plate which has been adopted as standard by the Kansas City Southern Ry., is now being tried out by the Delaware and Hudson R. R., and by the St. Louis and San Francisco Ry.

Cement Age.—This well known magazine, devoted to the popular features of cement construction as well as the engineering manufacturing side of the industry, has consolidated with *Concrete Engineering*, published in Cleveland, O., under the title: *Cement Age, With Which Is Combined Concrete Engineering*. It is proposed to preserve the best features of each magazine, thus maintaining the prestige each has won.

Triumph Electric Co.—This company, of Cincinnati, O., have recently opened a sales office at 728 Poydras St., New Orleans. This is the sixteenth sales office now being maintained by this company, and is the third to be opened during the past year. The Triumph Co., in their new factory are doing a big business, and anticipate even greater returns during the coming year. A large stock of machines will be carried at the New Orleans office for immediate shipment.

Michel-Kurze Co.—The organization of this company, with offices in the Hudson Terminal Buildings, New York, has just been effected to do photo retouching and illustrating of machinery subjects. The business will be managed by A. Eugene Michel, Assoc. Mem. Am. Soc. M. E. and the staff of artists will be in charge of Wm. F. Kurze, who was Art Director of the Scientific Engraving Co. during the past four years, and is one of New York's best known artists in mechanical lines.

Detroit Seamless Tube Co.—The above company announces that Joint Offices have been opened in the McCormick Building, Chicago, by the Detroit Seamless Steel Tubes Co., Michigan Malleable Iron Co., and the Monarch Steel Castings Co., all of Detroit, for the sale in the West and Southwest, of Detroit Locomotive Flues, Detroit Journal Boxes and Monarch Couplers. Walter E. Marvel, formerly Manager of the St. Louis office of The Buda Company, has been appointed Western Sales Manager in charge of the Chicago Offices.

Bettendorf Axle Co.—This company announces that F. K. Shults, until recently connected with the American Steel Foundries as their representative in New York and Eastern territory, has taken a similar position with the Bettendorf Axle Company, of Bettendorf, Iowa, and of which company he has been made a vice-president. Mr. Shults has opened an office in Room No. 2040 Grand Central Terminal Building, New York City; the office at No. 30 Church Street, Room No. 1021 Cortlandt Building, will remain in charge of G. N. Caleb, vice-president, who has been with the Bettendorf Company the last eight or ten years.

The Dearborn Drug & Chemical Works.—This company which has distributed its Feed Water Treatment and Lubricants through an agency in the Phillippines for the past two years, has decided to open their own branch office and warehouse in Manila, and F. O. Smolt, who has been connected with mining propositions since his graduation in Chemistry from the University of Illinois in the Class of '91, has become connected with the Dearborn Company, and sailed on January 7th for Manila, to take charge of this work, under the supervision of E. C. Brown, Manager of the Foreign Department of the Dearborn Company. Mr. Brown has spent most of the past two years in Japan, China and the Philippines, investigating steam plant and railroad conditions in the interests of Dearborn Products, and is still there, having made selling connection at Tokyo Tientsin, Hongkong and Shanghai.

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Locomotive, 2-8-8-2 Type AMER. ENG., 1911, p. 50 (February).

Total weight, 418,000 lbs.	Wheels, 57 in.
Weight on drivers, 360,000 lbs.	Total heating surface, 5,161.8 sq. ft.
Cylinders, 24½ and 39 in.	
Tractive effort, 83,300 lbs.	Steam pressure, 200 lbs.

Built by the American Locomotive Co. for pusher service on the 'Frisco lines. It is the first Mallet to be constructed with inside steam pipes to high pressure cylinders.

Locomotive, 4-4-2 Type AMER. ENG., 1911, p. 44 (February).

Total weight, 231,675 lbs.	Wheels, 73 in.
Weight on drivers, 112,125 lbs.	Total heating surface, 2,508 sq. ft.
Cylinders, 15 and 25 in.	
Tractive effort, 23,800 lbs.	Steam pressure, 220 lbs.

Built by Baldwin Locomotive Works for the Atchison, Topeka and Santa Fe Ry. It possesses the unique feature of outside dry and steam pipes and is the heaviest in total weight of any 4-4-2 type heretofore constructed.

Locomotive, 4-6-2 Type AMER. ENG., 1911, p. 56 (February).

Total weight, 250,500 lbs.	Wheels, 75 in.
Weight on drivers, 154,500 lbs.	Total heating surface, 3,328 sq. ft.
Cylinders, 25 in.	
Tractive effort, 37,700 lbs.	Steam pressure, 190 lbs.

Built by American Locomotive Co. for the Chicago and Northwestern R. R., where equipped with Schmidt superheater is giving excellent results in service.

Locomotive—Hollow Brick Arch

AMER. ENG., 1911, p. 58 (February).

Record of thorough test given the Wade-Nicholson hollow brick arch on a locomotive testing plant. These are apparently conclusive in establishing the increased economy of the hollow arch over that of the ordinary description.

Machine Tools—Cold Saw Cutting Off Machine

AMER. ENG., 1911, p. 74 (February).

New design of powerful metal saw built by the Newton Machine Tool Works, Inc.

Machine Tools—Heavy Duty Drill Press

AMER. ENG., 1911, p. 77 (February).

Very powerful tool built by Colburn Machine Tool Company, and especially designed for a wide range of heavy work.

Oil House—For the Santa Fe System

AMER. ENG., 1911, p. 52 (February).

Illustrated description of the equipment of the general oil distributing and storage plant at Topeka, Kans. The self-measuring pumps can transfer 300,000 gallons of oil in 10 hours. It is the largest and best equipped oil house in America.

Oxy-Acetylene Cutting Torch

AMER. ENG., 1911, p. 62 (February).

An illustrated article by J. F. Springer in which the application of the principle to metal cutting is fully described. A review of some noteworthy operations which have been performed through this process.

Shop Devices—Flue and Flue Sheet Tools

AMER. ENG., 1911, p. 65 (February).

Illustrated description of very ingenious flue beading tool which has been adopted on the Western Ry. of France. An exceedingly complicated device but possessing many points of merit.

Shop Devices—Cylinder Packing Ring Saw

AMER. ENG., 1911, p. 59 (February).

Illustrated description of very efficient double saw designed and built by Central of Georgia Ry. to dispense with hand work in fitting cylinder jacking rings.

Shop Devices—Tire Heater

AMER. ENG., 1911, p. 72 (February).

Illustrated description of a cheap and effective tool for heating tires when piled.

Locomotive Repair Shops at Brewster, Ohio

WHEELING & LAKE ERIE RAILROAD.

A COMPLETE LOCOMOTIVE REPAIR SHOP CONTAINING ALL EXCEPT THE POWERHOUSE AND STOREHOUSE WITHIN A SINGLE BUILDING. THE ERECTING SHOP IS OF THE TRANSVERSE TYPE AND THE TRANSFER TABLE IS REPLACED BY AN OVERHEAD CRANE OPERATED IN A BAY PARALLEL TO THE ERECTING SHOP AND BETWEEN IT AND THE MACHINE SHOP. PART OF THE BOILER SHOP OCCUPIES ONE END OF THIS TRANSFER BAY AND THE HANDLING OF HEAVY PARTS THROUGHOUT THE WHOLE SHOP IS WELL PROVIDED FOR.

Brewster, Ohio, has been founded by the Wheeling and Lake Erie Railroad at a point very near the geographical center of the system and there it has erected a complete new shop plant for making all repairs to its 225 locomotives. No other point on the road is provided with more than enough repair facilities to make the lightest kind of running repairs. Brewster is but 135 miles from the furthest terminal of the road, making it more economical to bring the power to this central point for all shop work than to maintain even moderate repair facilities at the various division points. Together with the shop there has also been erected a 26 stall roundhouse with a coal chute and other terminal facilities. A large freight yard has also been built at this point and freight car repairs will eventually be taken care of here.

While this company, together with the Wabash Pittsburg Terminal, now owns but 225 locomotives, the shop is designed to take care of all repairs on a total of 400 locomotives and therefore is not now being operated to its full capacity; nor has the full equipment of tools been provided for the capacity as designed.

It will be remembered that in the June, 1910, issue of this journal there appeared a general layout of this shop, together with a brief description of its general features. It was there noted that a unique idea formed the basis of the design of the erecting shop and the machine shop, viz., to build a transverse type of erecting shop, such as would ordinarily be constructed for use with a transfer table, and to then include the space devoted to the table within the shop building and to replace the table with an overhead crane, thus being able to make use of this space not only for transfer and admission to any track in the erecting shop, but also for the stripping, unwheeling, wheeling and finishing, as well as for storage of finished wheels, fitting of driving boxes, eccentrics, etc. This scheme effectually increases the capacity of the erecting shop by about 25 per cent. In practice it has been found convenient to use the pits located on every alternate track in the transfer bay, that may be opposite some engine in the erecting shop that is in for heavy boiler work, for light running repairs such as broken frames, tires turned, etc., and thus not take this class of work into the erecting shop proper at all.

General Arrangement.

Inasmuch as all the shops are grouped within one large building the general layout requires but little comment. The shop plant itself consists of but three structures—shops, storehouse and powerhouse. The roundhouse is located near the powerhouse and the hot water boiler washing and filling system apparatus is located therein, but in other respects it is independent of the shop. The oilhouse is mostly for road engine use, but of course it is made large enough to serve the shop. The strictly locomotive terminal section of the plant will be considered independently at a later point.

GENERAL VIEW OF STOREHOUSE AND MAIN SHOP BUILDING AT BREWSTER—W. & L. E. R. R.

The main shop building has been so placed as to permit easy extension at either end, in fact the end walls, while substantial, are considered temporary and the typography of the ground and location of the other buildings have been studied with this possibility in view. To the south of the shop building there is a clear space, about 100 ft. wide, covered by a 10 ton crane, with runways extending the full length of the building and a clear height of 36 ft. In this space are stored all heavy parts, such as wheel centers, frames, tires, axles, etc. The storehouse opposite the west end of the shop also adjoins this runway; in fact, its walls form the support for the girders, so that this crane becomes the principal and almost entire means of transfer of heavy raw material (except boiler plate, tubes and forgings) to the shop. Three tracks, serving the storehouse and scrap platform, extend under the crane, as do also the two entrance tracks to the shop, the connecting track between the shop and roundhouse and several connecting to the extensive system of narrow gauge track which covers the whole plant. In this manner this yard crane is given great flexibility for the transfer of material to and from cars, storehouse, roundhouse and storage space beneath it and any part of the shop. Entrance to the tender shop is from the west end and in the open space to the west of the shop are covered storage racks for tubes, bar iron, etc. The narrow gauge system furnishes the means of transfer from these points into

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Built by Baldwin Locomotive Works for the Atchison, Topeka and Santa Fe Ry. It possesses the unique feature of outside dry and steam pipes and is the heaviest in total weight of any 4-4-2 type heretofore constructed.

Locomotive, 4-6-2 Type Amer. Eng., 1911, p. 56 (February).

Total weight, 250,500 lbs.	Wheels, 75 in.
Weight on drivers, 154,500 lbs.	Total heating surface, 3,328 sq. ft.
Cylinders, 25 in.	
Tractive effort, 37,700 lbs.	Steam pressure, 190 lbs.

Built by American Locomotive Co. for the Chicago and North-western R. R., where equipped with Schmidt superheater is giving excellent results in service.

Locomotive—Hollow Brick Arch

Amer. Eng., 1911, p. 58 (February)

Record of thorough test given the Wade-Nicholson hollow brick arch on a locomotive testing plant. These are apparently conclusive in establishing the increased economy of the hollow arch over that of the ordinary description.

Machine Tools—Cold Saw Cutting Off Machine

Amer. Eng., 1911, p. 74 (February).

New design of powerful metal saw built by the Newton Machine Tool Works, Inc.

Machine Tools—Heavy Duty Drill Press

Amer. Eng., 1911, p. 7 (February).

Very powerful tool built by Colburn Machine Tool Company, and especially designed for a wide range of heavy work.

Oil House—For the Santa Fe System

Amer. Eng., 1911, p. 52 (February)

Illustrated description of the equipment of the general oil distributing and storage plant at Topeka, Kans. The self-measuring pumps can transfer 300,000 gallons of oil in 10 hours. It is the largest and best equipped oil house in America.

Oxy-Acetylene Cutting Torch

Amer. Eng., 1911, p. 62 (February).

An illustrated article by J. F. Springer in which the application of the principle to metal cutting is fully described. A review of some noteworthy operations which have been performed through this process.

Shop Devices—Flue and Flue Sheet Tools

Amer. Eng., 1911, p. 65 (February).

Illustrated description of very ingenious flue beading tool which has been adopted on the Western Ry. of France. An exceedingly complicated device but possessing many points of merit.

Shop Devices—Cylinder Packing Ring Saw

Amer. Eng., 1911, p. 59 (February)

Illustrated description of very efficient double saw designed and built by Central of Georgia Ry. to dispense with hand work in fitting cylinder jacking rings.

Shop Devices—Tire Heater

Amer. Eng., 1911, p. 72 (February)

Illustrated description of a cheap and effective tool for heating tires when piled.

Locomotive Repair Shops at Brewster, Ohio

WHEELING & LAKE ERIE RAILROAD.

A COMPLETE LOCOMOTIVE REPAIR SHOP CONTAINING ALL EXCEPT THE POWERHOUSE AND STOREHOUSE WITHIN A SINGLE BUILDING. THE ERECTING SHOP IS OF THE TRANSVERSE TYPE AND THE TRANSFER TABLE IS REPLACED BY AN OVERHEAD CRANE OPERATED IN A BAY PARALLEL TO THE ERECTING SHOP AND BETWEEN IT AND THE MACHINE SHOP. PART OF THE BOILER SHOP OCCUPIES ONE END OF THIS TRANSFER BAY AND THE HANDLING OF HEAVY PARTS THROUGHOUT THE WHOLE SHOP IS WELL PROVIDED FOR.

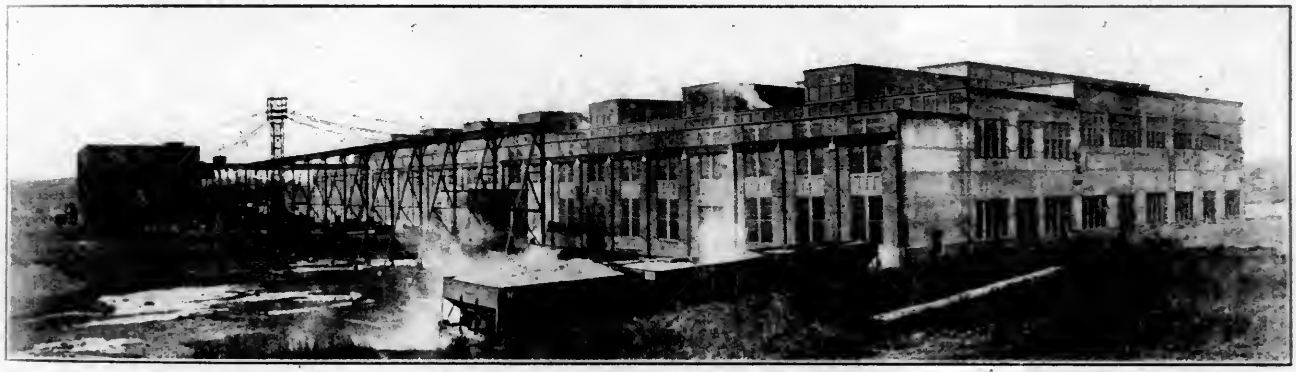
Brewster, Ohio, has been founded by the Wheeling and Lake Erie Railroad at a point very near the geographical center of the system and there it has erected a complete new shop plant for making all repairs to its 225 locomotives. No other point on the road is provided with more than enough repair facilities to make the lightest kind of running repairs. Brewster is but 135 miles from the furthest terminal of the road, making it more economical to bring the power to this central point for all shop work than to maintain even moderate repair facilities at the various division points. Together with the shop there has also been erected a 26 stall roundhouse with a coal chute and other terminal facilities. A large freight yard has also been built at this point and freight car repairs will eventually be taken care of here.

While this company, together with the Wabash Pittsburg Terminal, now owns but 225 locomotives, the shop is designed to take care of all repairs on a total of 400 locomotives and therefore is not now being operated to its full capacity; nor has the full equipment of tools been provided for the capacity as designed.

It will be remembered that in the June, 1910, issue of this journal there appeared a general layout of this shop, together with a brief description of its general features. It was there noted that a unique idea formed the basis of the design of the erecting shop and the machine shop, viz., to build a transverse type of erecting shop, such as would ordinarily be constructed for use with a transfer table, and to then include the space devoted to the table within the shop building and to replace the table with an overhead crane, thus being able to make use of this space not only for transfer and admission to any track in the erecting shop, but also for the stripping, unwheeling, wheeling and finishing, as well as for storage of finished wheels, fitting of driving boxes, eccentrics, etc. This scheme effectually increases the capacity of the erecting shop by about 25 per cent. In practice it has been found convenient to use the pits located on every alternate track in the transfer bay, that may be opposite some engine in the erecting shop that is in for heavy boiler work, for light running repairs such as broken frames, tires turned, etc., and thus not take this class of work into the erecting shop proper at all.

General Arrangement.

Inasmuch as all the shops are grouped within one large building the general layout requires but little comment. The shop plant itself consists of but three structures—shops, storehouse and powerhouse. The roundhouse is located near the powerhouse and the hot water boiler washing and filling system apparatus is located therein, but in other respects it is independent of the shop. The oilhouse is mostly for road engine use, but of course it is made large enough to serve the shop. The strictly locomotive terminal section of the plant will be considered independently at a later point.



GENERAL VIEW OF STOREHOUSE AND MAIN SHOP BUILDING AT BREWSTER—W. & L. E. R. R.

The main shop building has been so placed as to permit easy extension at either end, in fact the end walls, while substantial, are considered temporary and the typography of the ground and location of the other buildings have been studied with this possibility in view. To the south of the shop building there is a clear space, about 100 ft. wide, covered by a 10 ton crane, with runways extending the full length of the building and a clear height of 36 ft. In this space are stored all heavy parts, such as wheel centers, frames, tires, axles, etc. The storehouse opposite the west end of the shop also adjoins this runway; in fact, its walls form the support for the girders, so that this crane becomes the principal and almost entire means of transfer of heavy raw material (except boiler plate, tubes and forgings) to the shop. Three tracks, serving the storehouse and scrap platform, extend under the crane, as do also the two entrance tracks to the shop, the connecting track between the shop and roundhouse and several connecting to the extensive system of narrow gauge track which covers the whole plant. In this manner this yard crane is given great flexibility for the transfer of material to and from cars, storehouse, roundhouse and storage space beneath it and any part of the shop. Entrance to the tender shop is from the west end and in the open space to the west of the shop are covered storage racks for tubes, bar iron, etc. The narrow gauge system furnishes the means of transfer from these points into

the shop. A full gauge track connection enters both the boiler and smith shop from the west, allowing cars to be loaded and unloaded by the shop cranes. The storehouse is equally convenient to both the shop and the roundhouse, while the oilhouse is located near the latter. The powerhouse location was determined by the desire to have the hot water washing and filling system in it, which necessitated locating it near the roundhouse. It, of course, also furnishes steam to the shops for power and heating and a concrete tunnel has been built for carrying these as well as the air and water pipes. The electric circuits from the powerhouse are carried overhead on steel poles.

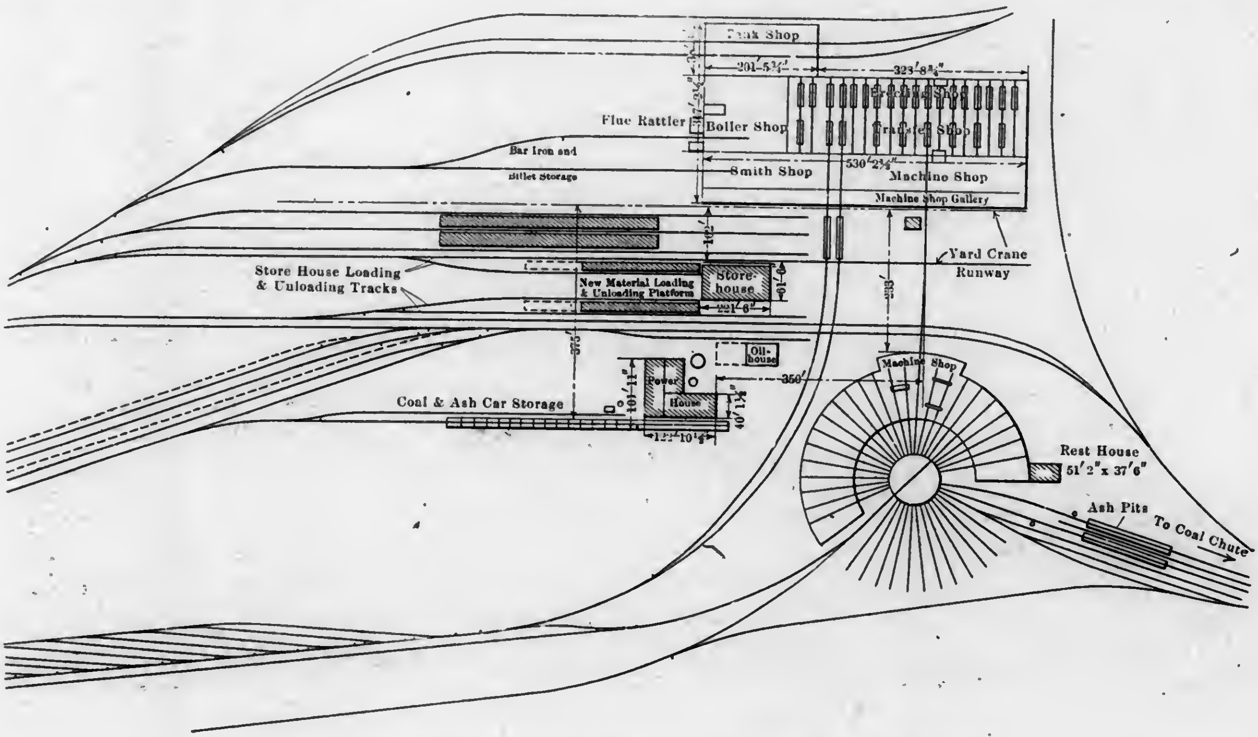
Main Shop Building.

This building includes the following distinct shops: Machine, transfer, erecting, boiler, blacksmith, tender and a small brass foundry. It is 528 ft. long, 226 ft. wide, with an extension to the north of 89 ft. for a distance of 201 ft. from the west end. This extension includes the tender and woodworking shops. The main building is divided into four bays longitudinally, the first bay, 65 ft. in width, for a distance of about 400 ft. from the east end forms the erecting shop. The second bay, for the same distance, is a transfer shop; the third, the heavy machine bay, and the fourth, the light machine bay. At the west end of the building on the gallery are the brass foundry and manufacturing tool room. Below this, and extending over the two bays, is the blacksmith shop. The boiler shop covers the space in the next two bays at this end, and the flue rattler is in a small addition outside the end wall, the tubes, however, being placed in it from the inside of the building, as will be explained later. In the tender shop there is a 55 ft. bay for general tank and truck work and a 30 ft. bay with a gallery where the woodworking machinery has been installed. On this gallery pilots, headlights, etc., are repaired and painted.

Like most recent shop buildings, this is a steel frame structure with enclosing walls of vitrified paving brick pierced with large windows. On every third pit are large transverse monitors, 22 ft. 9¾ in. wide and 12 ft. 3 in. high, formed of steel framework; having a flat roof and sides composed entirely of windows. This arrangement, together with the many windows in the side walls shown in the elevation drawing, makes the natural lighting of the floor very evenly distributed and of unusual intensity. In fact the shop seems to be provided with as good natural lighting as could possibly be desired. The accompanying drawings show the design and arrangement of the structure sufficiently well to make extended comment unnecessary. Attention might, however, be drawn to the floor construction, which is used throughout the whole building except in the forging section. This consists of 3 in. pine planking laid on a foundation of broken stone 6 in. thick, covered with 1 in. of tarred sand. Over this is laid at right angles a wearing surface of the best 1⅛ in. matched maple flooring in 4 in. strips. The floor support near the erecting pits consists of ties 2 ft. 6 in. long and 9 in. thick bolted to the top of the concrete pits. The rails are secured to the same ties, which are laid close together.

It will be noticed that pits have been provided on every second track in the transfer shop. These are, of course, for convenience in stripping and wheeling. Inasmuch as the locomotives are drawn in and out of the erecting shop on dollies or shop trucks and are taken to and from these small trucks by the large crane, they can be and are stripped and wheeled on some other pit than the one opposite their location in the erecting shop. This pit, of course, can be any one desired and therefore but half of the tracks in this section are thus provided, making it always possible to find a track with a pit vacant and allowing the alternate tracks to maintain the floor level and thus give a smooth surface for trucking and also a suitable place for fitting driving boxes, eccentrics, etc.

Overhead cranes serve the entire floor space of the shop with the exception of the galleries and the bays underneath them. In the erecting shop proper there is a 10 ton crane with a 65 ft span, the runways of which continue over the boiler shop. In the transfer bay there is a 150 ton double trolley crane with a 65 ft. span running the full length of the building, and a 10 ton single trolley crane on the same runway. In the heavy machine bay there is a 10 ton crane with a 55 ft. span running the full length of the building and serving the heavy forges in the blacksmith shop. A 30 ton crane with a 55 ft. span covers one bay of the tender shop. In addition to this the boiler shop and blacksmith shop tools and forges are very completely provided with jib cranes. The location and arrangement of each

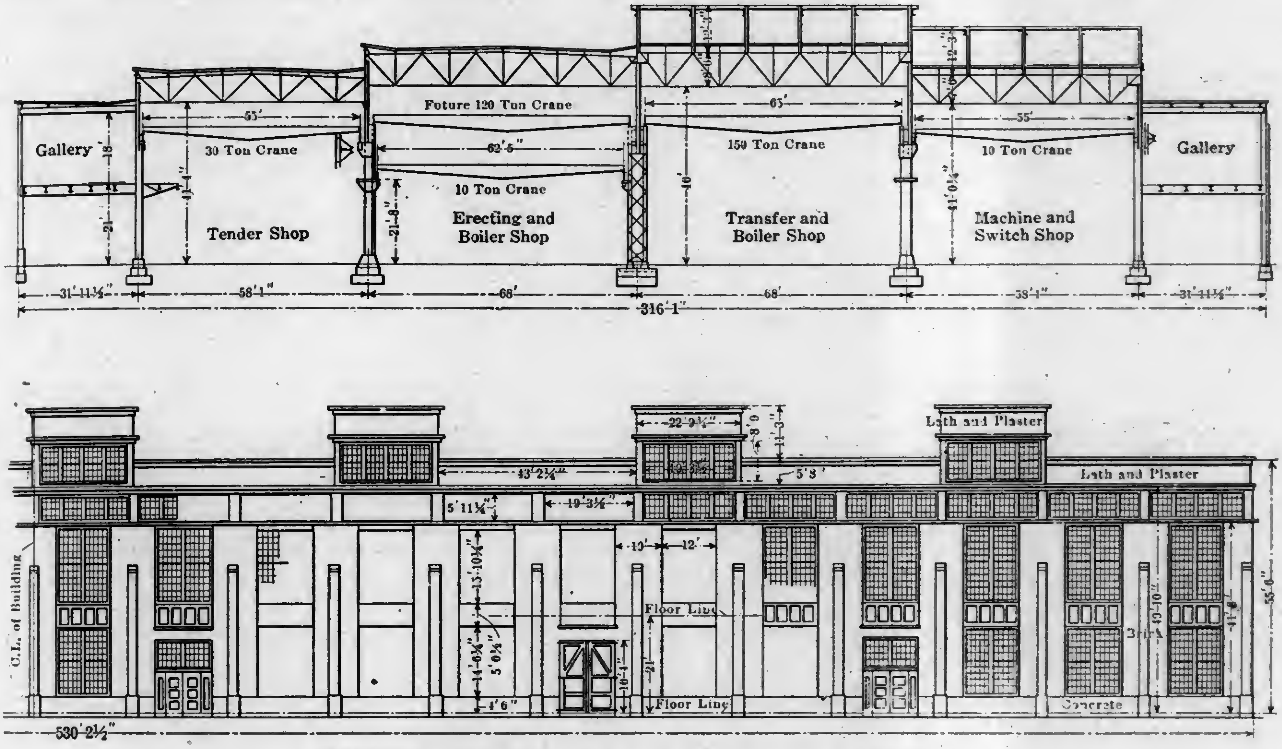


GENERAL ARRANGEMENT OF BREWSTER SHOPS—WHEELING AND LAKE ERIE RAILROAD.

are clearly shown in the plan. The hydraulic riveter, of course, has its own 25 ton crane. All of these cranes are from the Shaw Electric Crane Co.

The complete and elaborate system of narrow gauge tracks inside the shop are clearly shown in the illustration of the tool walls and columns. There are four of these fans, each driven by a 25 h.p. motor. The source of heat is the exhaust steam from the powerhouse.

The artificial lighting is all of enclosed arc lights suspended along the side walls and from the crane runways.



SECTION AND SIDE ELEVATION OF MAIN SHOP BUILDING AT BREWSTER.

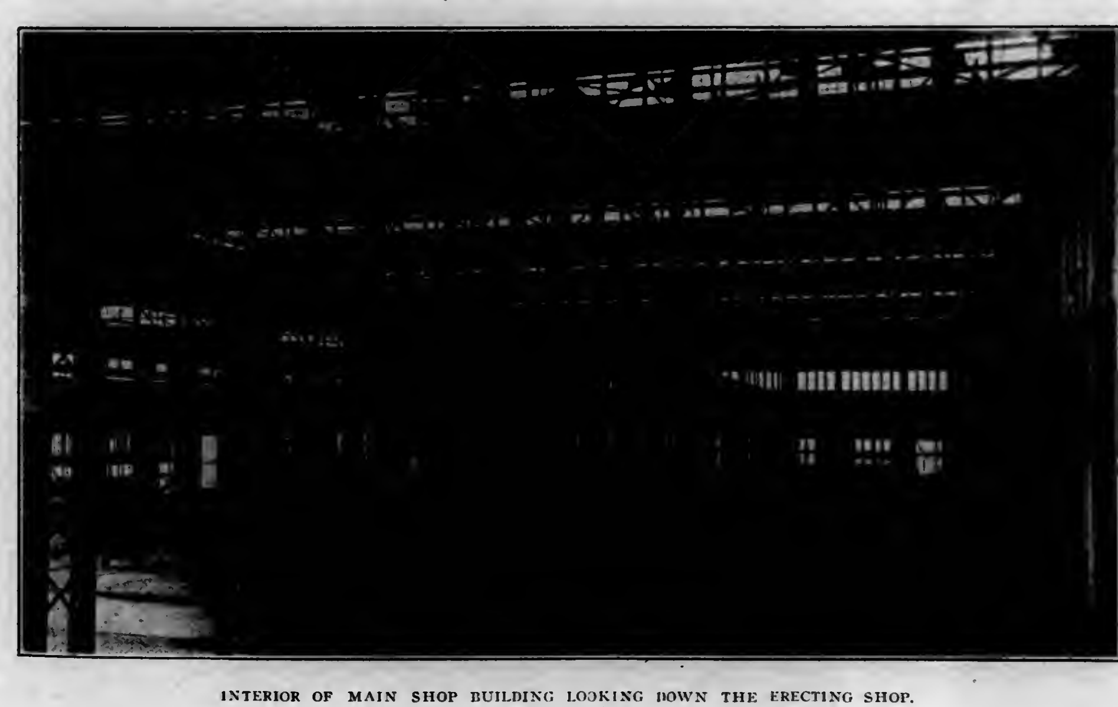
arrangement. It will be seen that through the medium of turntables it is possible to get a connection from this track system to any part of the shop and beneath any desired crane. This system is equally elaborate outside of the building and connects with all the storage centers, storehouse, etc.

The heating of the building is through the medium of hot air, the fans, which are electrically driven, being placed in the transverse monitors in the roof and the ducts are carried along the roof trusses with outlets at the various desired points along the

Electric power circuits with numerous plug boxes for the portable machine, lights and electric winch are provided throughout the whole building.

OPERATION.

Locomotives which are to be shopped are brought up over a washout pit just outside of the shop building on the entering track from the south. The details of this pit are shown in one of the illustrations. It consists simply of a basin built of con-



INTERIOR OF MAIN SHOP BUILDING LOOKING DOWN THE ERECTING SHOP.

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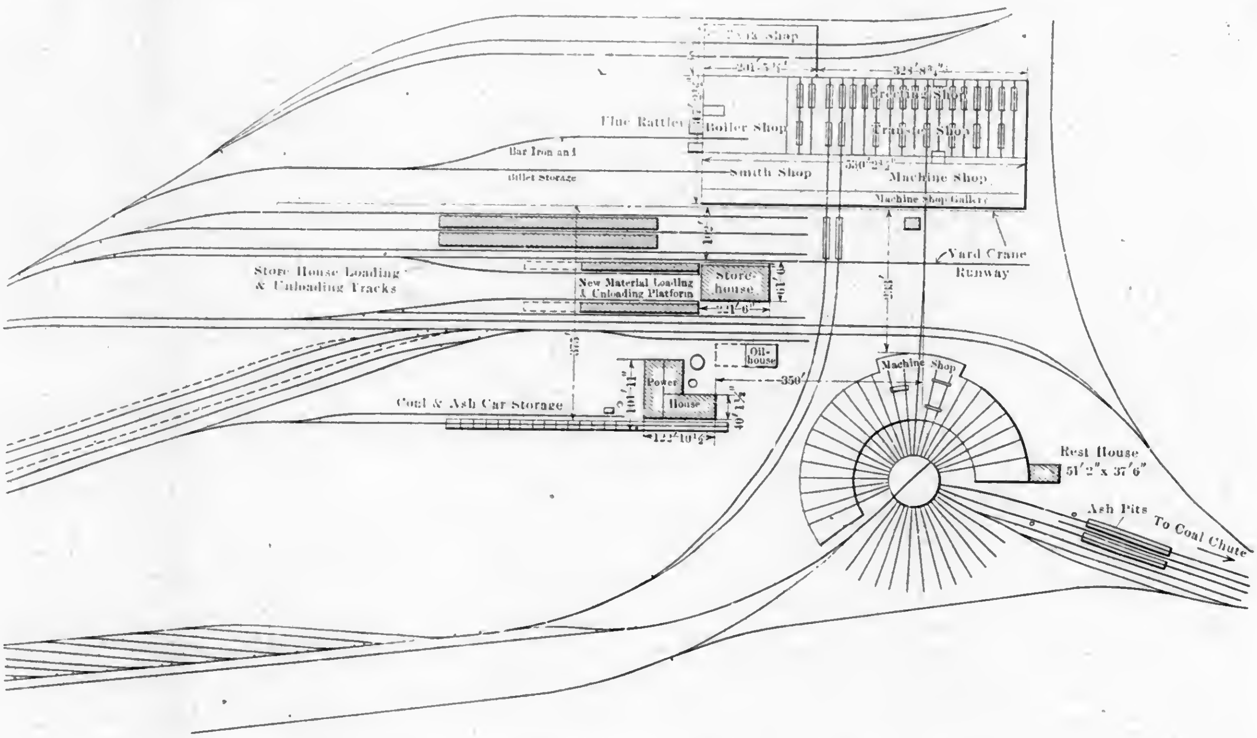

GENERAL ARRANGEMENT OF BREWSTER SHOPS—WHEELING AND LAKE ERIE RAILROAD.

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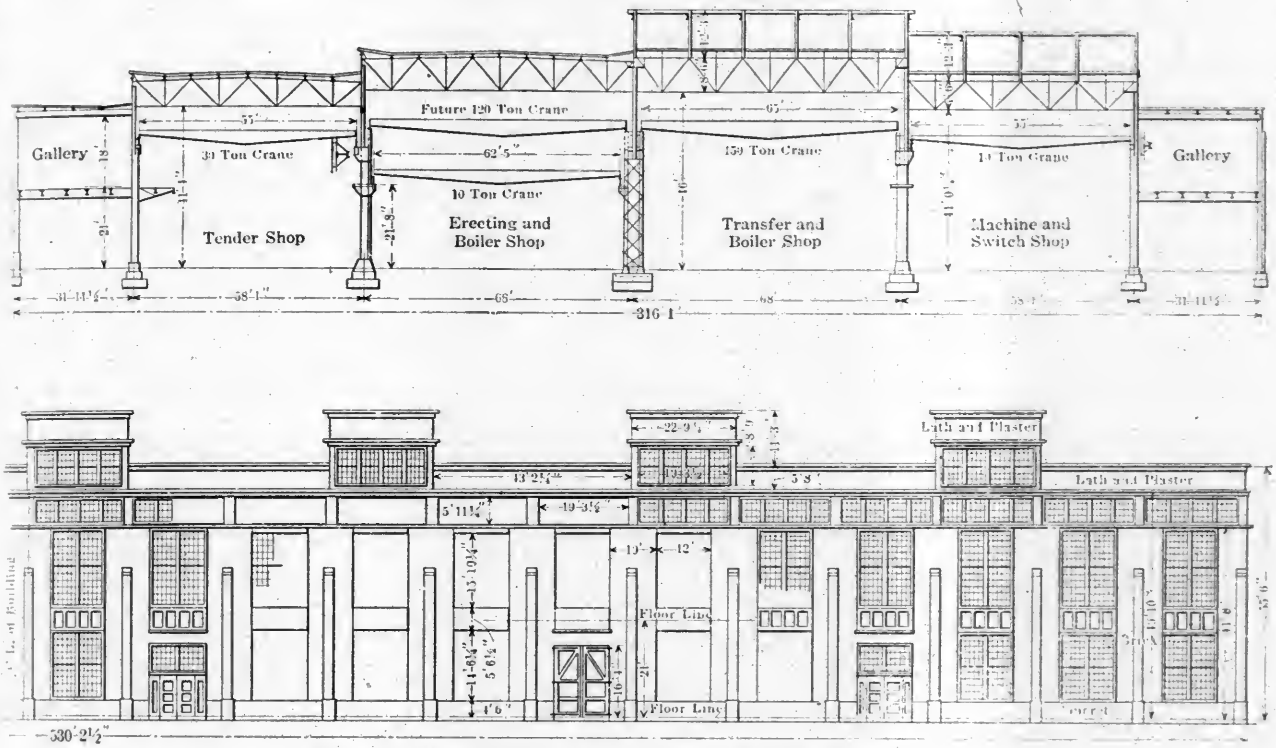

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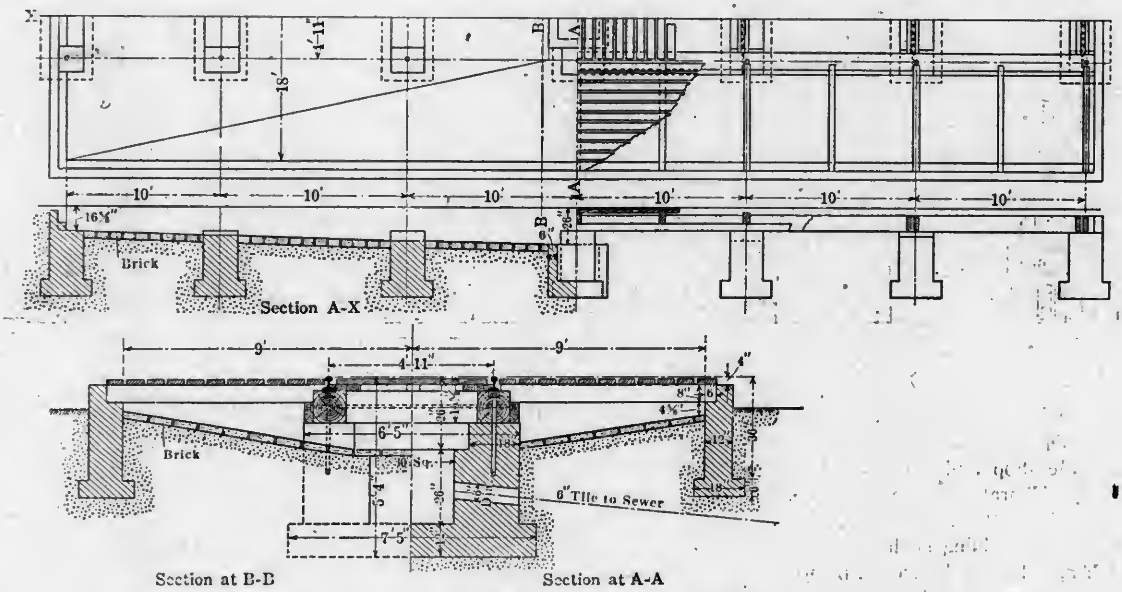
INTERIOR OF MAIN SHOP BUILDING LOOKING DOWN THE ERECTING SHOP.

crete and lined with brick, 60 ft. in length and 18 ft. wide, which drains to a large sump in the center. This basin is 26 in. in depth at the center and about 16 in. at the ends and sides and the track is carried across it on heavy timbers supported on concrete piers. It is covered over the top with a grating consisting of 3 in. planks set about 1 in. apart. A hot water connection is located nearby and the whole running gear of the locomotive is washed down with hot water before it is taken into the shop and practically all of the heavy dirt and grease is removed before it enters the shop at all. It is then pushed on to the pit in the transfer shop, made ready and lifted from the wheels by the 150 ton crane and carried down this shop to the point opposite the pit in the erecting shop where it is to be located. It is then set down upon the shop trucks and the work of stripping is completed. Racks are provided alongside these pits for storage of piping and parts not needing repairs. After the stripping is finished it is drawn into the erecting shop by an electric winch, the arrangement of which is shown in one of the illustrations. The drum of this winch carries a steel cable, which is run around a block at the further end of the erecting shop, intended to be the regular programme, but is often followed in the case of light repairs.

All wheels, rods, boxes, etc., left on the main incoming track after the locomotive is removed are disconnected and cleaned, the rods, boxes, springs, etc., being trucked to the hot water washing plant and cleaned before being distributed to the machine shop or racks. The wheels are rolled out on the same track the locomotive enters, underneath the 10 ton yard crane if it is desired to renew the tires. If, however, the tires are only to be turned they are, after cleaning, rolled under the 10 ton machine shop crane, which transfers them to wheel lathes. Tire heating is all performed in the small brick building, underneath the yard crane runway, which is provided with a jib crane and air hoist. Two large doors with roller steel shutters permit the wheels to be brought in or removed either to a track entering the machine and erecting shop or to the storage track.

In general the reversal of this scheme is followed for outgoing locomotives, a separate exit track alongside the incoming track being provided for this purpose.

Cabs, headlights and the pilots, etc., are lifted from the loco-



DETAILS OF WASHING PIT FOR LOCOMOTIVES.

there being a ring located in a recess in the floor at the end of each pit in both the erecting and transfer shop for securing the block. The cable is then drawn back to the coupler or other part of the locomotive and it is hauled into place in the erecting shop on the trucks. If the boiler is to be removed and taken to the boiler shop it is necessary to either bring the locomotive again into the transfer shop or to prepare the boiler for removal before the engine is taken to the erecting shop at all, as the large crane is used for this purpose and the boilers are repaired in the section of the boiler shop underneath its runway. Inasmuch as it is a comparatively simple matter to transfer a locomotive from the erecting shop to the transfer shop, it depends upon circumstances which method is followed. Flue work is performed in the section of the boiler shop near the west end underneath the 10 ton crane runway and this crane transfers the flues from the locomotive to the rattler and from the repaired flue racks back to the locomotive. Although the flue rattler is in a leanto outside of the building, there is a swinging steel door in the end wall and guides extending inside of the main shop, so that the flues can be deposited by the crane and slid into the rattler without any extra handling. They can also be removed in the same manner.

If necessary the whole locomotive, including its wheels, can be lifted by the 150 ton crane and carried over the tops of other locomotives in the transfer shop to the desired pit, and there repaired or removed from its wheels. This, however, is not motive by the 10 ton crane in the erecting shop and set down upon push cars on the narrow gauge track, which transfers them to the crane or elevator in the tender shop.

Machine Tool Layout and Work Distribution.

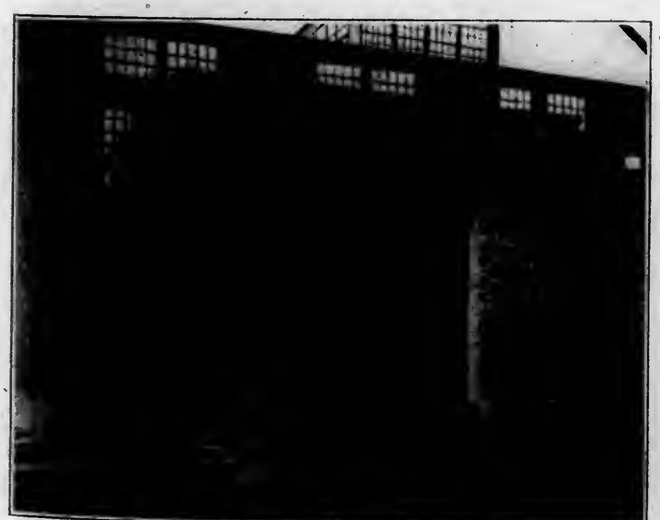
In studying the arrangement of tools as shown on the accompanying illustration it should be remembered that in a shop of this size devoted entirely to repair work there is not sufficient of any one class of work to keep particular machines or particular groups entirely supplied, and that while a particular machine is selected and located on a basis of the work which it will principally perform, it will also be called upon to do work of a character to which neither its design or location is especially well suited. Therefore it is not possible in a shop of this size to attain the high degree of perfection in the distribution of the work or of the grouping and classification of the machines. In this case it was also necessary to make use of considerable machinery that was already at hand in too good a condition to permit scrapping. The new tools purchased are of the highest character and show an intimate knowledge of both the work to be performed and the railroad machine tool industry.

Beginning at the east end of the heavy machine bay there is a 36 by 36 in. by 10 ft. Chandler planer used on rod brasses, guide yokes, guide yoke knees, eccentric rods, etc. This is driven by a 20 h.p. motor. The next machine is a No. 10 Newton vertical milling machine used for rod work. It is driven by a 10 h.p. motor. There is then a Newton two spindle rod borer, each

spindle being driven by a 7½ h.p. motor. This machine is used for main and side rod boring and miscellaneous heavy drilling.

Following this there is a group belted to a line shaft driven by a 35 h.p. motor, consisting of a 21 in. Betts slotter for connecting rod straps, cross heads, links, etc.; a 34 in. Fitchburg radial drill for drilling, tapping and reaming rod oil cups, large rod bolts, etc.; a swing grinder for rods and straps and a 79 in. Niles wheel lathe for tires and wheel centers. The next machine on this side of the shop is a 90 in. Niles wheel lathe, direct driven by a 30 h.p. motor. This adjoins the transverse full gauge track which runs from the erecting shop to the roundhouse. On the other side of the track is a 90 in. Niles wheel press, direct driven by a 7 h.p. motor and near by is a small babbitt furnace for counterbalance weights. Following this is a 42 in. by 11 ft. Schumacher and Boye triple geared lathe for axles, crank pins, etc. This is driven by a 15 h.p. motor. A high speed Niles radial drill driven by a 20 h.p. motor used on driving boxes, hub plates and miscellaneous heavy drilling is next, and is adjoined by a 66 in. Niles boring mill for wheel centers, tires, etc., and an 84 in. Betts boring mill for smoke box fronts, dome bases, smoke box rings, etc.; the latter machine is driven by a 10 h.p. motor and the former by a 35 h.p. motor.

On the opposite side of the heavy machine bay practically all of the machines are of the lighter variety, which do not require the service of an overhead crane. These machines are mostly driven from the line shafting with the groups in the light machine bay and form part of these groups. The first group at this end of the shop is belted from a line shaft supported in the center below the gallery and driven by a 50 h.p. motor. Beginning at the east end this consists of a 16 in. Niles slotter for driving box wedges, valve stem yokes, etc.; a No. 3 Bement horizontal boring mill for lift shafts and engine truck cradles; a 51 in. Bullard boring mill for boring and facing driving boxes, hub plates, etc.; a 36 in. by 8 ft. Pond lathe for reach rod jaws and washers; an 18 in. Cincinnati shaper for crown brasses, eccentric straps, etc.; a 56 by 56 in. by 6 ft. Gray planer for driving boxes, shoes and wedges, cellars, etc.; a 42 in. Lodge and Shipley lathe for miscellaneous work; a 72 in. Niles radial drill located underneath the crane runway for drilling and tapping cylinders and other miscellaneous heavy drilling. A Lucas power forcing press for pressing in brasses, etc.; a 24 in. by 10 ft. horizontal milling machine for link hangers, reverse levers, throttle levers, stub ends, etc.; a 42 in. Bullard boring mill for cylinder



TIRE HEATING BUILDING UNDER YARD CRANE.

heads and miscellaneous boring; a 60 in. Bickford radial drill for cylinder heads, steam chests, etc., and a 36 in. Bullard vertical turret lathe for piston packing, piston heads, cylinder heads, valve bushings, etc. In addition to these machines there is a 56 in. by 56 in. by 16 ft. Pond planer, direct driven by an 18 h.p. motor, for crosshead gibs, eccentric rods, main rod brasses, etc., and a Landis piston rod grinder, which is direct driven by a 15 h.p. motor.

In the next group, driven by a 40 h.p. motor, there is a 27 in. by 8 ft. Pond lathe; a small sensitive drill; a 24 in. by 8 ft. Pond lathe; a 32 in. by 9 ft. 8 in. Schumacher and Boye lathe; a 24 in. Enterprise shaper; two 24 in. by 8 ft. 6 in. Lodge and Shipley lathes; a 24 in. Fifefield lathe and a swinging grinder in addition to the tool grinders in the distributing tool room. A 36 in. by 36 in. by 12 ft. Fitchburg planer direct driven by a 10 h.p. motor forms part of this same group of tools. All of these

ELECTRIC WINCH FOR PULLING LOCOMOTIVES TO AND FROM THE ERECTING SHOP.

tools are used on miscellaneous valve gear and motion work.

At the east end of the gallery are the smaller tools for use on motion work, supplementing those located on the main floor under the gallery. A 7 by 10 ft. elevator gives connection between the two floors at this point. Practically all of these tools are devoted to work on valve gears, cross heads, throttle valves and pipes, steam pipes, etc. They consist of the following tools, all belted from a line shaft driven by a 50 h.p. motor:

32 in. by 8 ft. Schumacher and Boye Lathe.
42 in. by 9 ft. 8 in. Fitchburg Lathe.
Bement, Miles Radial Drill.
20 in. by 7 ft. Lathe.
36 in. by 36 in. by 12 ft. Pond Planer (15 h.p. Motor, Direct Drive).
Swinging Grinder.
15 in. Bement Slotter.
Hammett Link Grinder.
24 in. Pond Lathe.
60 in. Bickford Radial Drill.
24 in. Niles Slotter.
Diamond Guide Grinder.
21 in. by 5 ft. 6 in. Star Lathe.
Two 24 in. Pond Lathes.
18 in. Flather Lathe.
36 in. American Drill.
Swinging Grinder.

Adjoining this group on the gallery is a space for air brake repairs, which in turn is followed by the manufacturing tool room in which the tools are arranged to form one group driven by a 20 h.p. motor. Following this is the bolt room, where all knuckle pins, studs, staybolts, etc, are manufactured. The names and arrangements of the tools at this point is clearly shown in the illustration. At the far end of the gallery is a small brass foundry, separated by a partition. Just outside of this partition are several tools for brass work. The tools here are in two groups driven by 20 h.p. motors.

On the main floor under the gallery directly below the bolt room are the machines, furnaces, and benches for spring work. There is also space and several machines for the pipe work located nearby. The remainder of this end of the shop, covering

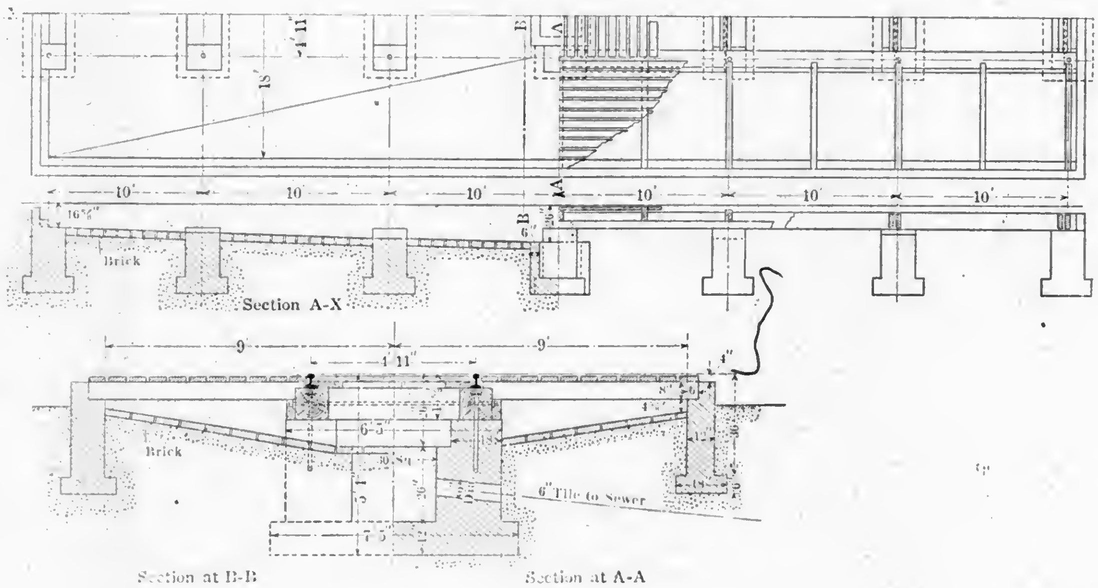
crete and lined with brick, 60 ft. in length and 18 ft. wide, which drains to a large sump in the center. This basin is 26 in. in depth at the center and about 16 in. at the ends and sides and the track is carried across it on heavy timbers supported on concrete piers. It is covered over the top with a grating consisting of 3 in. planks set about 1 in. apart. A hot water connection is located nearby and the whole running gear of the locomotive is washed down with hot water before it is taken into the shop and practically all of the heavy dirt and grease is removed before it enters the shop at all. It is then pushed on to the pit in the transfer shop, made ready and lifted from the wheels by the 150 ton crane and carried down this shop to the point opposite the pit in the erecting shop where it is to be located. It is then set down upon the shop trucks and the work of stripping is completed. Racks are provided alongside these pits for storage of piping and parts not needing repairs. After the stripping is finished it is drawn into the erecting shop by an electric winch, the arrangement of which is shown in one of the illustrations. The drum of this winch carries a steel cable, which is run around a block at the further end of the erecting shop,

intended to be the regular programme, but is often followed in the case of light repairs.

All wheels, rods, boxes, etc., left on the main incoming track after the locomotive is removed are disconnected and cleaned, the rods, boxes, springs, etc., being trucked to the hot water washing plant and cleaned before being distributed to the machine shop or racks. The wheels are rolled out on the same track the locomotive enters, underneath the 10 ton yard crane if it is desired to renew the tires. If, however, the tires are only to be turned they are, after cleaning, rolled under the 10 ton machine shop crane, which transfers them to wheel lathes. Tire heating is all performed in the small brick building, underneath the yard crane runway, which is provided with a jib crane and air hoist. Two large doors with roller steel shutters permit the wheels to be brought in or removed either to a track entering the machine and erecting shop or to the storage track.

In general the reversal of this scheme is followed for outgoing locomotives, a separate exit track alongside the incoming track being provided for this purpose.

Cabs, headlights and the pilots, etc., are lifted from the loco-



DETAILS OF WASHING PIT FOR LOCOMOTIVES.

there being a ring located in a recess in the floor at the end of each pit in both the erecting and transfer shop for securing the block. The cable is then drawn back to the coupler or other part of the locomotive and it is hauled into place in the erecting shop on the trucks. If the boiler is to be removed and taken to the boiler shop it is necessary to either bring the locomotive again into the transfer shop or, to prepare the boiler for removal before the engine is taken to the erecting shop at all, as the large crane is used for this purpose and the boilers are repaired in the section of the boiler shop underneath its runway. Inasmuch as it is a comparatively simple matter to transfer a locomotive from the erecting shop to the transfer shop, it depends upon circumstances which method is followed. Flue work is performed in the section of the boiler shop near the west end underneath the 10 ton crane runway and this crane transfers the flues from the locomotive to the rattler and from the repaired flue racks back to the locomotive. Although the flue rattler is in a leanto outside of the building, there is a swinging steel door in the end wall and guides extending inside of the main shop, so that the flues can be deposited by the crane and slid into the rattler without any extra handling. They can also be removed in the same manner.

If necessary the whole locomotive, including its wheels, can be lifted by the 150 ton crane and carried over the tops of other locomotives in the transfer shop to the desired pit, and there repaired or removed from its wheels. This, however, is not

motive by the 10 ton crane in the erecting shop and set down upon push cars on the narrow gauge track, which transfers them to the crane or elevator in the tender shop.

Machine Tool Layout and Work Distribution.

In studying the arrangement of tools as shown on the accompanying illustration it should be remembered that in a shop of this size devoted entirely to repair work there is not sufficient of any one class of work to keep particular machines or particular groups entirely supplied, and that while a particular machine is selected and located on a basis of the work which it will principally perform, it will also be called upon to do work of a character to which neither its design or location is especially well suited. Therefore it is not possible in a shop of this size to attain the high degree of perfection in the distribution of the work or of the grouping and classification of the machines. In this case it was also necessary to make use of considerable machinery that was already at hand in too good a condition to permit scrapping. The new tools purchased are of the highest character and show an intimate knowledge of both the work to be performed and the railroad machine tool industry.

Beginning at the east end of the heavy machine bay there is a 36 by 36 in. by 10 ft. Chandler planer used on rod brasses, guide yokes, guide yoke knees, eccentric rods, etc. This is driven by a 20 h.p. motor. The next machine is a No. 10 Newton vertical milling machine used for rod work. It is driven by a 10 h.p. motor. There is then a Newton two spindle rod borer, each

spindle being driven by a 7½ h.p. motor. This machine is used for main and side rod boring and miscellaneous heavy drilling.

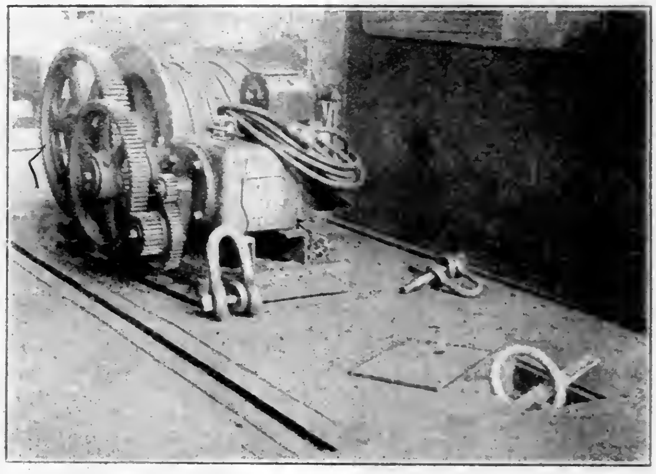
Following this there is a group belted to a line shaft driven by a 35 h.p. motor, consisting of a 21 in. Betts slotter for connecting rod straps, cross heads, links, etc.; a 34 in. Fitchburg radial drill for drilling, tapping and reaming rod oil cups, large rod bolts, etc.; a swing grinder for rods and straps and a 79 in. Niles wheel lathe for tires and wheel centers. The next machine on this side of the shop is a 90 in. Niles wheel lathe, direct driven by a 30 h.p. motor. This adjoins the transverse full gauge track which runs from the erecting shop to the roundhouse. On the other side of the track is a 90 in. Niles wheel press, direct driven by a 7 h.p. motor and near by is a small babbitt furnace for counterbalance weights. Following this is a 42 in. by 11 ft. Schumacher and Boye triple geared lathe for axles, crank pins, etc. This is driven by a 15 h.p. motor. A high speed Niles radial drill driven by a 20 h.p. motor used on driving boxes, hub plates and miscellaneous heavy drilling is next, and is adjoined by a 66 in. Niles boring mill for wheel centers, tires, etc., and an 84 in. Betts boring mill for smoke box fronts, dome bases, smoke box rings, etc.; the latter machine is driven by a 10 h.p. motor and the former by a 35 h.p. motor.

On the opposite side of the heavy machine bay practically all of the machines are of the lighter variety, which do not require the service of an overhead crane. These machines are mostly driven from the line shafting with the groups in the light machine bay and form part of these groups. The first group at this end of the shop is belted from a line shaft supported in the corner below the gallery and driven by a 50 h.p. motor. Beginning at the east end this consists of a 16 in. Niles slotter for driving box wedges, valve stem yokes, etc.; a No. 3 Bement horizontal boring mill for lift shafts and engine truck cradles; a 51 in. Bullard boring mill for boring and facing driving boxes, hub plates, etc.; a 36 in. by 8 ft. Pond lathe for reach rod jaws and washers; an 18 in. Cincinnati shaper for crown brasses, eccentric straps, etc.; a 56 by 56 in. by 6 ft. Gray planer for driving boxes, shoes and wedges, cellars, etc.; a 42 in. Lodge and Shipley lathe for miscellaneous work; a 72 in. Niles radial drill located underneath the crane runway for drilling and tapping cylinders and other miscellaneous heavy drilling. A Lucas power forcing press for pressing in brasses, etc.; a 24 in. by 10 ft. horizontal milling machine for link hangers, reverse levers, throttle levers, stub ends, etc.; a 42 in. Bullard boring mill for cylinder

TIRE HEATING BUILDING UNDER YARD CRANE.

heads and miscellaneous boring; a 60 in. Bickford radial drill for cylinder heads, steam chests, etc., and a 36 in. Bullard vertical turret lathe for piston packing, piston heads, cylinder heads, valve bushings, etc. In addition to these machines there is a 56 in. by 56 in. by 16 ft. Pond planer, direct driven by an 18 h.p. motor, for crosshead gibs, eccentric rods, main rod brasses, etc., and a Landis piston rod grinder, which is direct driven by a 15 h.p. motor.

In the next group, driven by a 40 h.p. motor, there is a 27 in. by 8 ft. Pond lathe; a small sensitive drill; a 24 in. by 8 ft. Pond lathe; a 32 in. by 9 ft. 8 in. Schumacher and Boye lathe; a 24 in. Enterprise shaper; two 24 in. by 8 ft. 0 in. Lodge and Shipley lathes; a 24 in. Fifefield lathe and a swinging grinder in addition to the tool grinders in the distributing tool room. A 36 in. by 36 in. by 12 ft. Fitchburg planer direct driven by a 10 h.p. motor forms part of this same group of tools. All of these



ELECTRIC WINCH FOR PULLING LOCOMOTIVES TO AND FROM THE ERECTING SHOP.

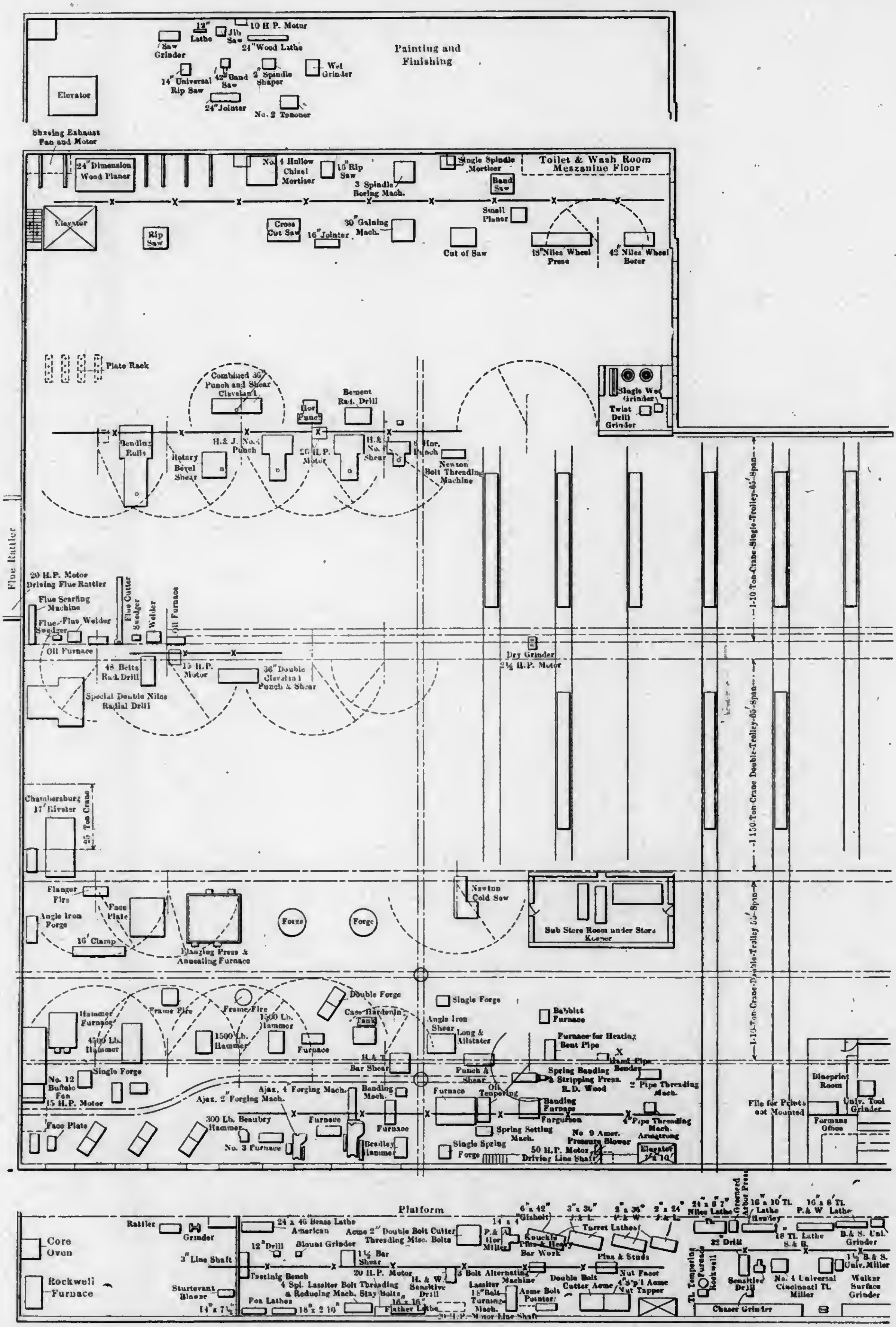
tools are used on miscellaneous valve gear and motion work.

At the east end of the gallery are the smaller tools for use on motion work, supplementing those located on the main floor under the gallery. A 7 by 10 ft. elevator gives connection between the two floors at this point. Practically all of these tools are devoted to work on valve gears, cross heads, throttle valves and pipes, steam pipes, etc. They consist of the following tools, all belted from a line shaft driven by a 50 h.p. motor:

32 in. by 8 ft. Schumacher and Boye Lathe.
42 in. by 9 ft. 8 in. Fitchburg Lathe.
Bement, Miles Radial Drill.
20 in. by 7 ft. Lathe.
36 in. by 36 in. by 12 ft. Pond Planer (15 h.p. Motor, Direct Drive).
Swinging Grinder.
15 in. Bement Shaper.
Hammett Link Grinder.
24 in. Pond Lathe.
60 in. Bickford Radial Drill.
24 in. Niles Slotter.
Diamond Guide Grinder.
21 in. by 5 ft. 6 in. Star Lathe.
Two 24 in. Pond Lathes.
18 in. Flather Lathe.
36 in. American Drill.
Swinging Grinder.

Adjoining this group on the gallery is a space for air brake repairs, which in turn is followed by the manufacturing tool room in which the tools are arranged to form one group driven by a 20 h.p. motor. Following this is the bolt room, where all knuckle pins, studs, staybolts, etc., are manufactured. The names and arrangements of the tools at this point is clearly shown in the illustration. At the far end of the gallery is a small brass foundry, separated by a partition. Just outside of this partition are several tools for brass work. The tools here are in two groups driven by 20 h.p. motors.

On the main floor under the gallery directly below the bolt room are the machines, furnaces, and benches for spring work. There is also space and several machines for the pipe work located nearby. The remainder of this end of the shop, covering



PLAN OF BUILDING AND LOCATION.

two bays, forms the blacksmith shop. In this there are two heavy forging machines, three large steam hammers, one of 4,500 lbs. capacity, oil furnaces for flanging, in addition to the usual forges, a Bradley power hammer, punches and shears, etc.

The next bay is given up to heavy boiler work, and consists principally of open floor space for handling complete boilers. At the end of the shop there is a hydraulic riveter with a 17 ft. gap and nearby a special double Niles radial drill, each drill being driven by a 20 h.p. motor. Alongside the row of columns are placed a 48 in. Betts radial drill and a 36 in. Cleveland punch and shear. A hydraulic mud ring riveter carried by a jib crane is also located in this section of the shop. In the next bay are the machines for forming and punching boiler plate and also for flue work. It will be noticed that these machines also adjoin the tank shop and can be used on tank plate, if desired. There are several other machines located on the other side of the columns intended especially for tank repairs.

In the woodworking shop are the usual collection of woodworking machine tools necessary for repairing tank frames, pilots and other locomotives and steam shovel parts. The names, sizes and arrangements of these machines is clearly shown in the illustration.

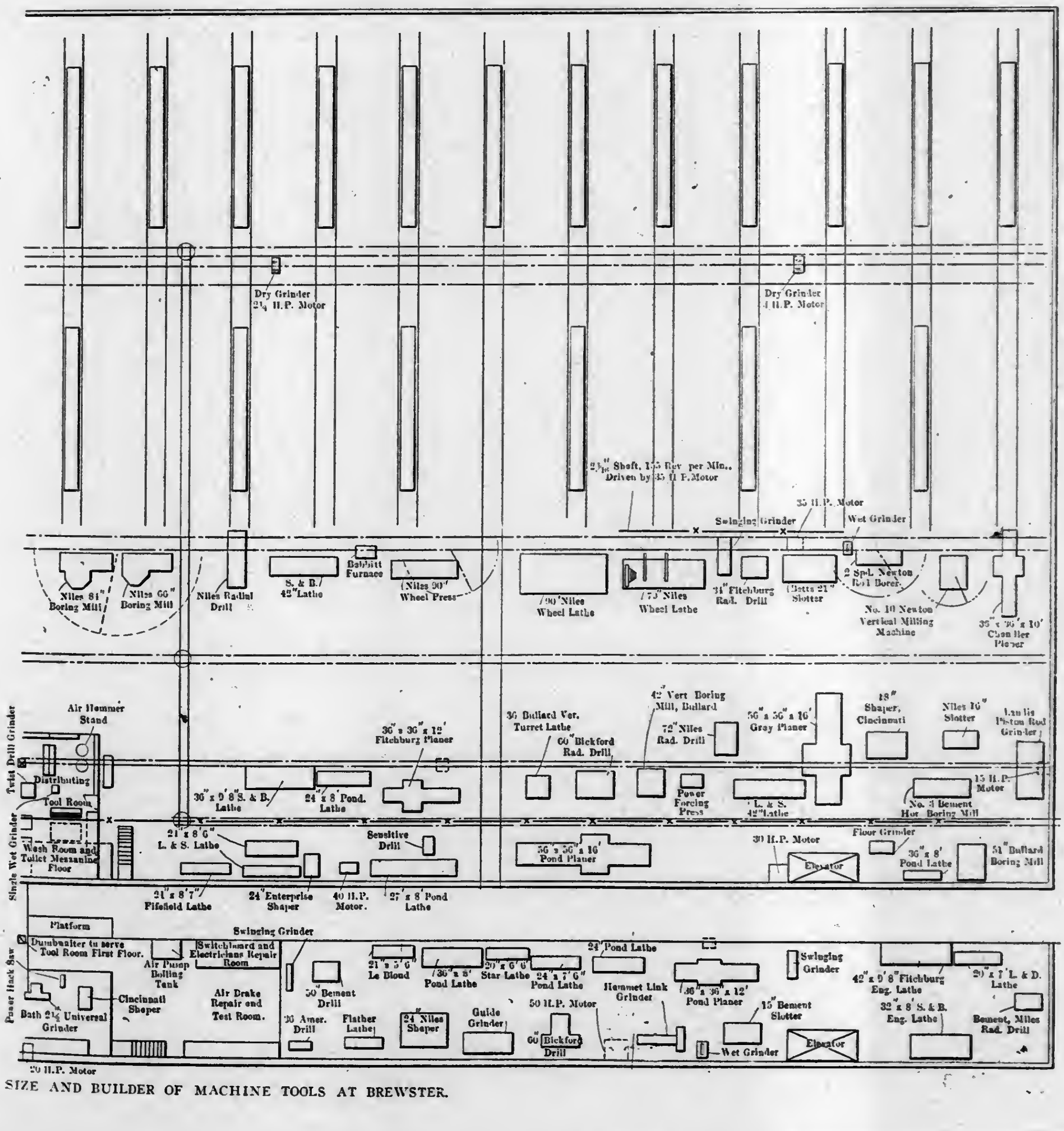
It will be noticed that there are no tools except one drill provided especially for cylinder work. All cylinders are purchased completely machined except drilling and finishing the smokebox fit.

Storehouse.

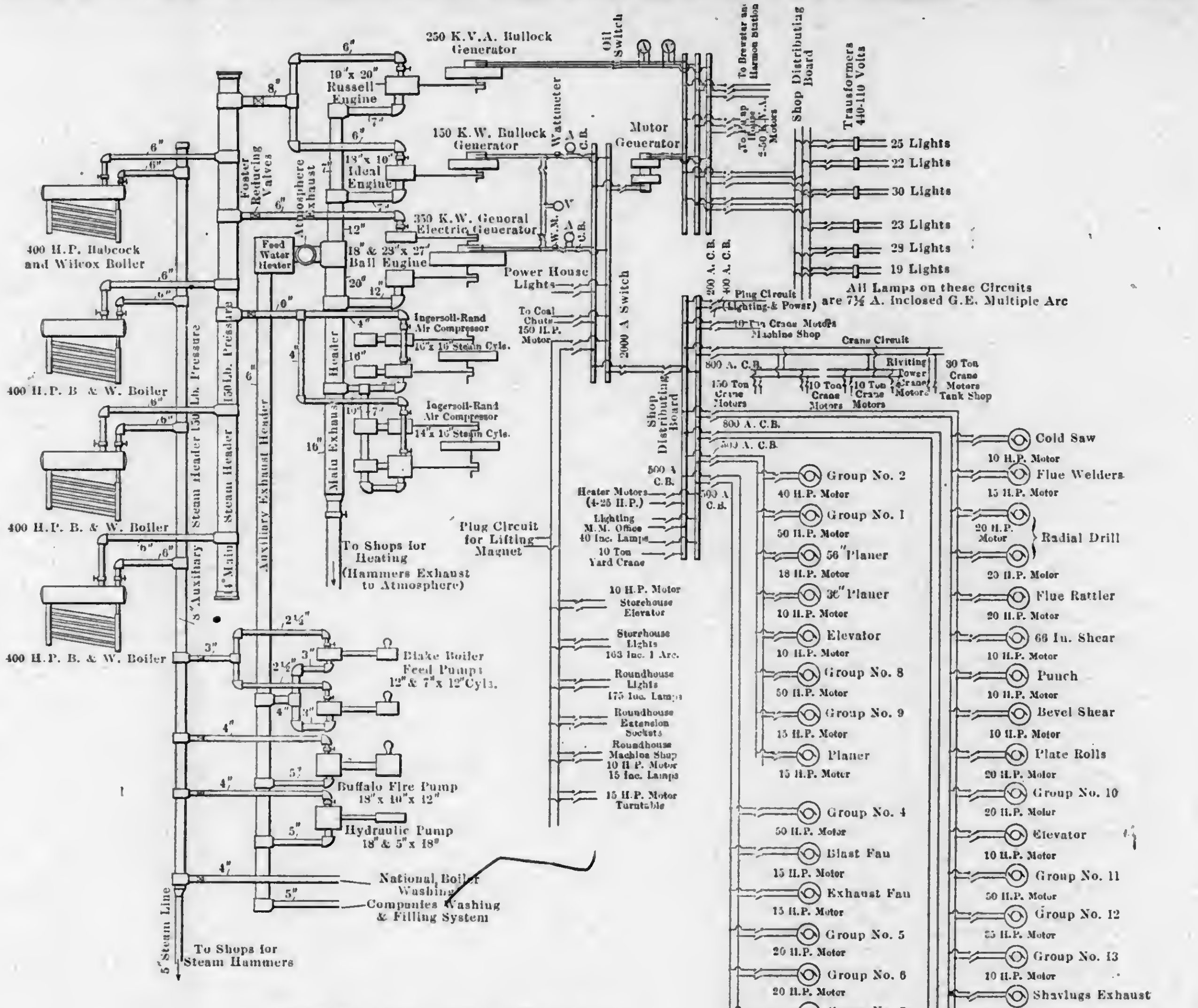
The storehouse building is a three story brick structure on a concrete foundation and presents no novelty of design or arrangement. The building itself is used only for the storage of small parts, and is provided with an elevator of suitable size and capacity. It is the central storehouse for the system and maintains a supply of the usual stores required for train and track service as well as for the shop. Castings, bar iron stock, tubes, pipes and other heavy parts belonging to the store stock are stored on platforms or in racks at some point convenient to the part of the shop in which they are to be used. A sub store is maintained in the main shop, where small supplies in constant use can be obtained immediately.

Powerhouse.

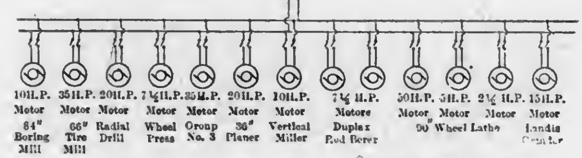
Reference to the diagram showing the power distribution will show the equipment located in the powerhouse, the exterior appearance of which is shown in one of the other illustrations. It will be seen that there is one 250 kw. alternating current generator direct connected to a 19 by 20 Russell engine and that this current is used at the shop altogether for lighting.



SIZE AND BUILDER OF MACHINE TOOLS AT BREWSTER.



Total Horse Power of Direct Current Motors
Exclusive of Cranes=1165½



GROUP NO. 1.
50 H. P. MOTOR.
16 in. Slotter.
18 in. Shaper.
Horizontal Boring Machine.
51 in. Boring Mill.
36 in. Lathe.
Floor Grinder.
56 by 56 in. by 16 ft. Planer.
42 in. Lathe.
72 in. Radial Drill.
Power Forcing Press.
42 in. Boring Mill.
60 in. Radial Drill.
36 in. Vertical Turret Lathe.

GROUP NO. 2.
40 H. P. MOTOR.
24 in. Lathe.
36 in. Lathe.
27 in. Lathe.
Sensitive Drill.
Floor Grinder.
24 in. Shaper.
24 in. Lathe.
24 in. Lathe.
24 in. Lathe.
Swing Grinder.
Tool Grinder.
Drill Grinder.
Wet Grinder.

GROUP NO. 3.
35 H. P. MOTOR.
21 in. Slotter.
34 in. Radial Drill.
Swinging Grinder.
79 in. Wheel Lathe.

GROUP NO. 4.
50 H. P. MOTOR.
4 in. Pipe Threading Machine.
2 in. Pipe Threading Machine.
Pressure Blower.
Spring Banding Press.
Punch and Shear.
Angle Iron Shear.
Bradley Hammer.
Bar Shear.
4 in. Forging Machine.
2 in. Forging Machine.
Beaudry Hammer.

GROUP NO. 5 (GALLERY).
20 H. P. MOTOR.
Sturdevant Blower.
24 in. Brass Lathe.
14 in. Fox Lathe.
18 in. Fox Lathe.
12 in. Drill.
Grinder.
1½ in. Bar Shear.
Lassiter Bolt Threader.
16 in. Lathe.

GROUP NO. 6.
20 H. P. MOTOR.
Sensitive Drill.
2 in. Bolt Cutter.
14 in. Horizontal Miller.
Lassiter Bolt Turning Machine.
Bolt Pointer.
6 in. Turret Lathe.
3 in. Turret Lathe.
2 in. Turret Lathes.
Bolt Altering Machine.
Double Bolt Cutter.
4 Spindle Nut Tapper.
Nut Facer.

GROUP NO. 7.
(Tool Room.)
20 H. P. MOTOR.
24 in. Lathe.
Arbor Press.
16 in. Lathe.
18 in. Lathe.
16 in. Lathe.
Universal Grinder.
32 in. Drill.
Sensitive Drill.
No. 4 Universal Miller.
No. 1½ Universal Miller.
Power Hack Saw.
Shaper.

GROUP NO. 8.
50 H. P. MOTOR.
Radial Drill.
32 in. Lathe.
20 in. Lathe.
42 in. Lathe.
Swinging Grinder.
36 by 36 in. by 12 ft. Planer.
24 in. Lathe.
Hammett Link Grinder.
60 in. Bickford Drill.
24 in. Lathe.
20 in. Lathe.
36 in. Lathe.
21 in. Lathe.
24 in. Shaper.
Flather Lathe.
50 in. Drill.
Swinging Grinder.
36 in. Radial Drill.

GROUP NO. 9.
15 H. P. MOTOR.
48 in. Radial Drill.
36 in. Punch and Shear.
2 Flue Swages.
2 Flue Welders.
Flue Cutters.
Flue Scarfing Machine.

GROUP NO. 10.
20 H. P. MOTOR.
36 in. Punch and Shear.
8 in. Horizontal Punch.
Radial Drill.
8 in. Horizontal Punch.
Bolt Threading Machine.

GROUP NO. 11.
50 H. P. MOTOR.
24 in. Wood Planer.
Rip Saw.
Hollow Chisel Mortiser.
Cross Cut Saw.
16 in. Rip Saw.
16 in. Jointer.

GROUP NO. 12.
35 H. P. MOTOR.
3 Spindle Boring Machine.
Single Spindle Mortiser.
Band Saw.
30 in. Gaining Machine.
Cut-off Saw.
Wood Planer.
18 in. Wheel Press.
42 in. Wheel Borer.

GROUP NO. 13.
10 H. P. MOTOR.
24 in. Jointer.
No. 2 Tenoner.
2 Spindle Shaper.
42 in. Band Saw.
Rip Saw.
Grinder.
24 in. Pattern Makers' Lathe.
12 in. Pattern Makers' Lathe.
Saw Grinder.
Jig Saw.

POWER DISTRIBUTION AT BREWSTER.

It is also used for driving the centrifugal pumps at the pumping house located some distance away. There are two direct current generators, one 150 kw. Bullock and one 350 kw. General Electric, the latter being driven by an 18 by 28 by 27 in. cross compound Ball engine and the former by an 18 by 16 in. Ideal engine. This current is employed for all machine tool motors, crane motors and incandescent lighting. Between the direct current and the alternating current bus bars has been connected a motor generator which will permit any of the generators to be operated alone and furnish current for all kinds of work. The method of connection and general arrangement of the circuits is shown on the power distribution diagram.

The hydraulic pump and accumulator are located in the power house and piped to the riveters in the boiler shop through the concrete tunnel connecting the two buildings.

GENERAL VIEW SHOWING POWERHOUSE, STOREHOUSE AND MAIN SHOP.

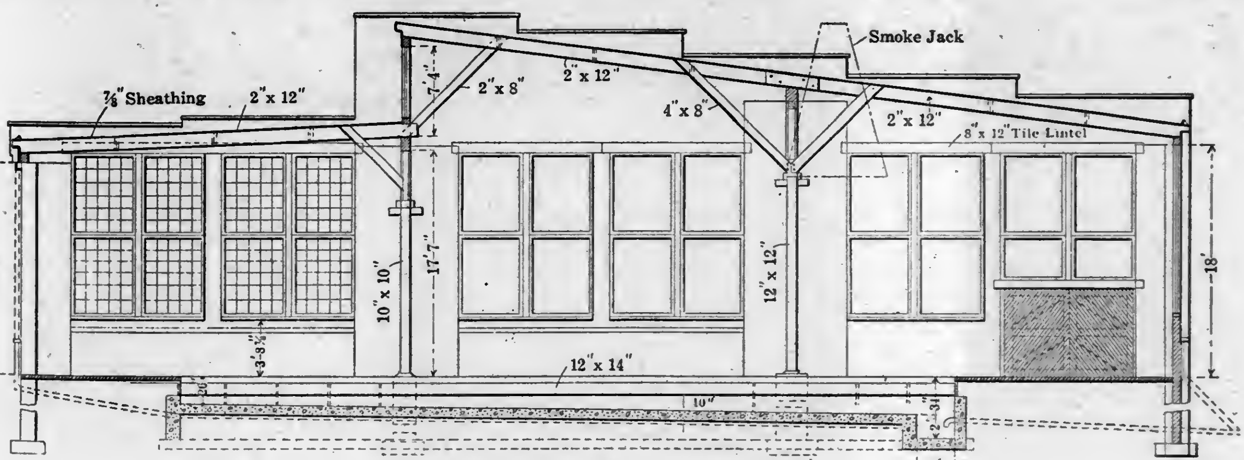
Draft is furnished by a 150 ft. chimney 9 ft. in diameter, made of radial brick. The coal for firing the four 400 h.p. Babcock and Wilcox boilers is brought in on a trestle alongside the power-house. Automatic Roney stokers have been installed with the boilers. Ashes are handled in the tunnel under the boilers and deposited into empty coal cars at the end of the trestle by means of a self-discharging air hoist arrangement, in which the buckets are drawn up over the top of the cars and discharged and returned automatically.

Water service is provided from three tanks, one of 100,000 gals. capacity, giving a head of 32 ft., and one of 265,000 gals. capacity, giving a head of 50 ft. at the powerhouse and one of 100,000 gals. capacity and a head of 50 ft. at the roundhouse. This service is for locomotive stand pipes and fire, as well as for shop use.

Locomotive Terminal.

This section of the improvement was designed by the chief engineer of the railroad, H. T. Douglas, Jr., and consists of a 26 stall roundhouse with a 90 ft. turntable, a trestle type coaling station and a small roundhouse machine shop, together with the usual ash pits, inspection pits, etc.

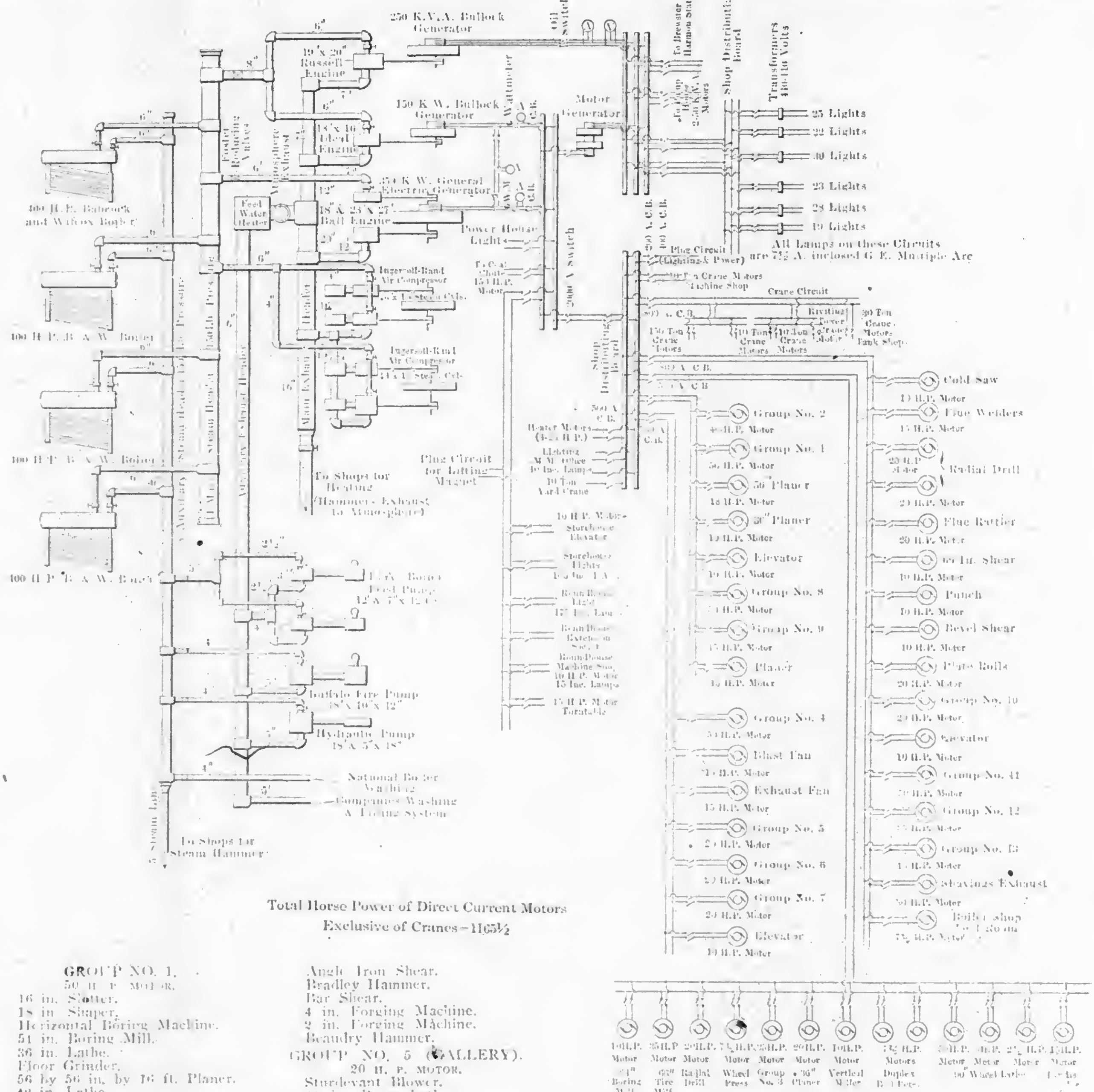
The roundhouse is 90 ft. between walls and is constructed on the cross section shown in the engraving. The outer and end walls are composed principally of vitrified tile and the roof structure is of wood. The usual swinging doors with large lighting area are provided. Near the center of the house there is a driving wheel drop pit covering two tracks and two truck wheel pits covering the next two tracks. The machine shop is an extension on the outer wall near the drop pits and contains a small planer, forge, lathe and drill. It is simply intended for emergency repair work.



SECTION OF ROUNDHOUSE ERECTED AT BREWSTER.

Coaling Station.—This is a wooden structure, of the trestle type, on concrete foundations, the cars being drawn up by a cable from an electric winch. There are ten pockets, five on either side. The gates are of the under-cut type. On the same structure there are three bins for the storage of wet sand, the cars being unloaded into them from the trestle track. These bins discharge by gravity into the stove dryer and the sand is lifted into the dry sand bin by air in the usual manner.

Just east of the coaling station there are two large concrete inspection pits, each 130 ft. long, allowing the inspection of two locomotives on either track.



GROUP NO. 1.
50 H. P. MOTOR.

16 in. Slotter.
18 in. Shaper.
Horizontal Boring Machine.
51 in. Boring Mill.
36 in. Lathe.
Floor Grinder.
56 by 56 in. by 16 ft. Planer.
42 in. Lathe.
72 in. Radial Drill.
Power Forging Press.
42 in. Boring Mill.
60 in. Radial Drill.
36 in. Vertical Turret Lathe.

GROUP NO. 2.
40 H. P. MOTOR.

24 in. Lathe.
36 in. Lathe.
27 in. Lathe.
Sensitive Drill.
Floor Grinder.
24 in. Shaper.
24 in. Lathe.
24 in. Lathe.
24 in. Lathe.
Swing Grinder.
Tool Grinder.
Drill Grinder.
Wet Grinder.

GROUP NO. 3.
35 H. P. MOTOR.

24 in. Slotter.
34 in. Radial Drill.
Swinging Grinder.
79 in. Wheel Lathe.

GROUP NO. 4.
50 H. P. MOTOR.

4 in. Pipe Threading Machine.
2 in. Pipe Threading Machine.
Pressure Blower.
Spring Banding Press.
Punch and Shear.
Angle Iron Shear.
Bradley Hammer.
Bar Shear.
4 in. Forging Machine.
2 in. Forging Machine.
Beaudry Hammer.

GROUP NO. 5 (GALLERY).
20 H. P. MOTOR.

Sturdevant Blower.
24 in. Brass Lathe.
14 in. Fox Lathe.
18 in. Fox Lathe.
12 in. Drill.
Grinder.
1½ in. Bar Shear.
Lassiter Bolt Threader.
16 in. Lathe.

GROUP NO. 6.
20 H. P. MOTOR.

Sensitive Drill.
2 in. Bolt Cutter.
14 in. Horizontal Miller.
Lassiter Bolt Turning Machine.
Bolt Pointer.
6 in. Turret Lathe.
3 in. Turret Lathe.
2 in. Turret Lathes.
Bolt Altering Machine.
Double Bolt Cutter.
4 Spindle Nut Tapper.
Nut Facer.

GROUP NO. 7.
(Tool Room.)
20 H. P. MOTOR.

24 in. Lathe.
Arbor Press.
16 in. Lathe.
18 in. Lathe.
16 in. Lathe.
Universal Grinder.
32 in. Drill.
Sensitive Drill.
No. 4 Universal Miller.
No. 1½ Universal Miller.
Power Hack Saw.
Shaper.

GROUP NO. 8.
50 H. P. MOTOR.

Radial Drill.
32 in. Lathe.
20 in. Lathe.
42 in. Lathe.
Swinging Grinder.
36 by 36 in. by 12 ft. Planer.
24 in. Lathe.
Hammett Link Grinder.
60 in. Bickford Drill.
24 in. Lathe.
20 in. Lathe.
36 in. Lathe.
24 in. Lathe.
24 in. Shaper.
Flather Lathe.
50 in. Drill.
Swinging Grinder.
36 in. Radial Drill.

GROUP NO. 9.
15 H. P. MOTOR.

48 in. Radial Drill.
36 in. Punch and Shear.
2 Flue Swages.
2 Flue Welders.
Flue Cutters.
Flue Scarfing Machine.

GROUP NO. 10.
20 H. P. MOTOR.

36 in. Punch and Shear.
8 in. Horizontal Punch.
Radial Drill.
8 in. Horizontal Punch.
Bolt Threading Machine.

GROUP NO. 11.
50 H. P. MOTOR.

24 in. Wood Planer.
Rip Saw.
Hollow Chisel Mortiser.
Cross Cut Saw.
16 in. Rip Saw.
16 in. Jointer.

GROUP NO. 12.
35 H. P. MOTOR.

3 Spindle Boring Machine.
Single Spindle Mortiser.
Band Saw.
30 in. Gaining Machine.
Cut-off Saw.
Wood Planer.
18 in. Wheel Press.
42 in. Wheel Borer.

GROUP NO. 13.
10 H. P. MOTOR.

24 in. Jointer.
No. 2 Tenoner.
2 Spindle Shaper.
42 in. Band Saw.
Rip Saw.
Grinder.
24 in. Pattern Makers' Lathe.
12 in. Pattern Makers' Lathe.
Saw Grinder.
Jig Saw.

POWER DISTRIBUTION AT BREWSTER.

it is also used for driving the centrifugal pumps at the pumping house located some distance away. There are two direct current generators, one 150 kw. Bullock and one 350 kw. General Electric, the latter being driven by an 18 by 28 by 27 in. cross compound Ball engine and the former by an 18 by 16 in. Ideal engine. This current is employed for all machine tool motors, crane motors and incandescent lighting. Between the direct current and the alternating current bus bars has been connected a motor generator which will permit any of the generators to be operated alone and furnish current for all kinds of work. The method of connection and general arrangement of the circuits is shown on the power distribution diagram.

The hydraulic pump and accumulator are located in the power house and piped to the riveters in the boiler shop through the concrete tunnel connecting the two buildings.

Draft is furnished by a 150 ft. chimney 9 ft. in diameter, made of radial brick. The coal for firing the four 400 h.p. Babcock and Wilcox boilers is brought in on a trestle alongside the power-house. Automatic Roney stokers have been installed with the boilers. Ashes are handled in the tunnel under the boilers and deposited into empty coal cars at the end of the trestle by means of a self-discharging air hoist arrangement, in which the buckets are drawn up over the top of the cars and discharged and returned automatically.

Water service is provided from three tanks, one of 100,000 gals. capacity, giving a head of 32 ft., and one of 265,000 gals. capacity, giving a head of 50 ft. at the powerhouse and one of 100,000 gals. capacity and a head of 50 ft. at the roundhouse. This service is for locomotive stand pipes and fire, as well as for shop use.

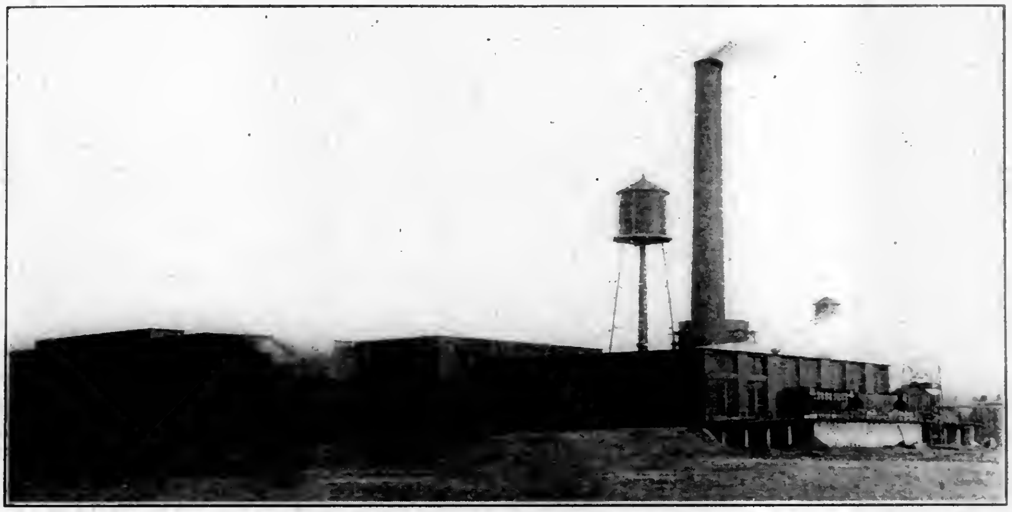
LOCOMOTIVE TERMINAL.

This section of the improvement was designed by the chief engineer of the railroad, H. T. Douglas, Jr., and consists of a 26 stall roundhouse with a 90 ft. turntable, a trestle type coaling station and a small roundhouse machine shop, together with the usual ash pits, inspection pits, etc.

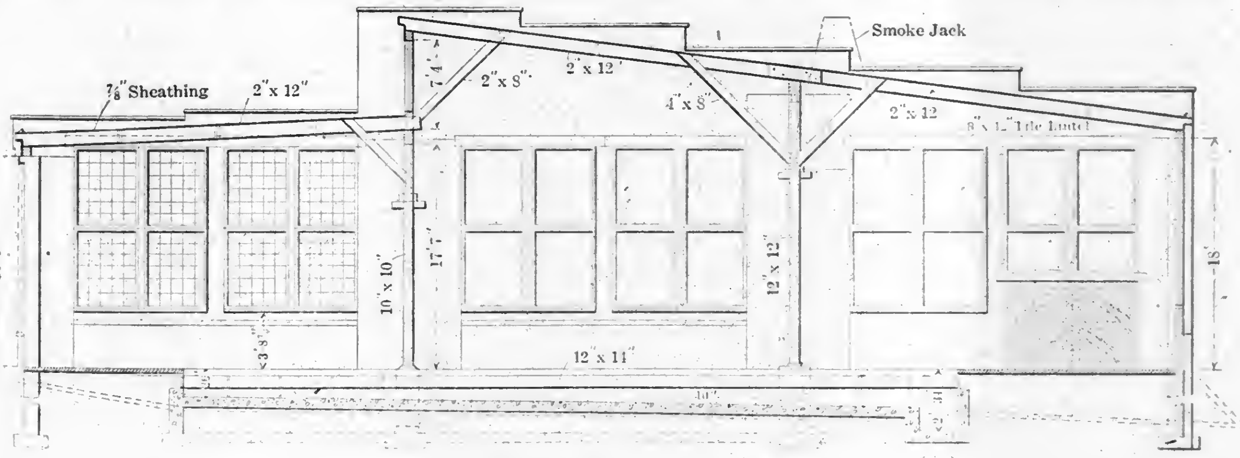
The roundhouse is 90 ft. between walls and is constructed on the cross section shown in the engraving. The outer and end walls are composed principally of vitrified tile and the roof structure is of wood. The usual swinging doors with large lighting area are provided. Near the center of the house there is a driving wheel drop pit covering two tracks and two truck wheel pits covering the next two tracks. The machine shop is an extension on the outer wall near the drop pits and contains a small planer, forge, lathe and drill. It is simply intended for emergency repair work.

Coaling Station.—This is a wooden structure, of the trestle type, on concrete foundations, the cars being drawn up by a cable from an electric winch. There are ten pockets, five on either side. The gates are of the under-cut type. On the same structure there are three bins for the storage of wet sand, the cars being unloaded into them from the trestle track. These bins discharge by gravity into the stove dryer and the sand is lifted into the dry sand bin by air in the usual manner.

Just east of the coaling station there are two large concrete inspection pits, each 130 ft. long, allowing the inspection of two locomotives on either track.



GENERAL VIEW SHOWING POWERHOUSE, STOREHOUSE AND MAIN SHOP.



SECTION OF ROUNDHOUSE ERECTED AT BREWSTER.

The ash pits, which are of the usual shovel type with the outer rail on the side wall, are located near the turntable as is customary and proper. The general plan of the whole shop shows the track arrangement and inter-relation of these various parts. A rest house and engine dispatcher's office forms an addition on the east end of the roundhouse structure.

The roundhouse is provided with the hot boiler washing and filling system, designed and erected by the National Boiler Washing Co.*

This shop was planned and erected under the direction of V. Z. Caracristi, J. E. Muhlfeld acting in a consulting capacity, the buildings being detailed and erected by Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.

* For a full description of this system see AMERICAN ENGINEER AND RAILROAD JOURNAL, December, 1910, page 468.

Powerful Locomotives of the 2-6-6-2 Type

CHICAGO, MILWAUKEE & ST. PAUL RY.

THE AMERICAN LOCOMOTIVE COMPANY HAS RECENTLY DELIVERED 25 MALLET LOCOMOTIVES TO THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, TO BE USED IN REGULAR ROAD SERVICE AND AS PUSHERS. THEY HAVE A TOTAL WEIGHT OF 390,000 LBS. AND A MAXIMUM TRACTIVE EFFORT OF 75,000 LBS.

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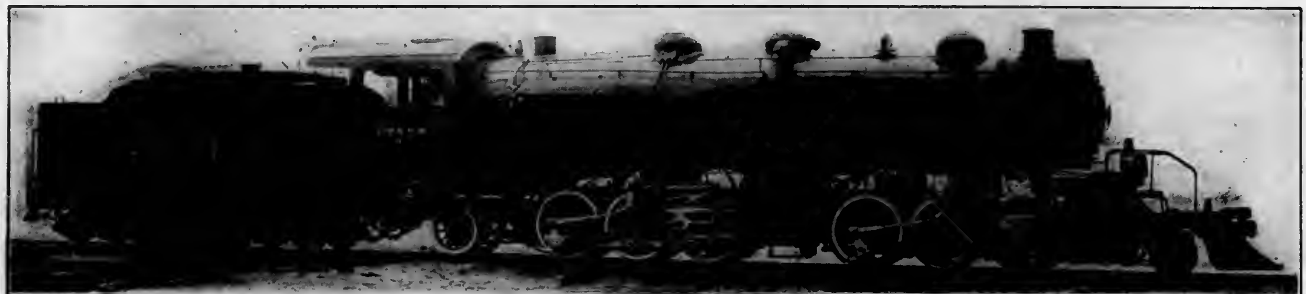
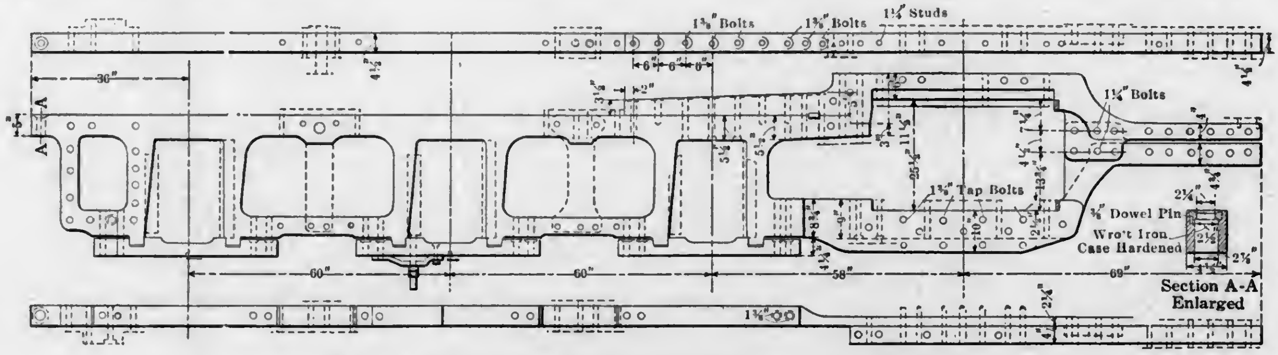


LOCOMOTIVE WITH VERY LARGE BOILER FOR REGULAR ROAD SERVICE.

While the general design is very similar to the Chesapeake & Ohio engines, there has been some noticeable changes. The steam pressure has been reduced to 200 lbs. and larger cylinders and a shorter stroke have been specified. The cylinders of the Milwaukee engines are 23½ and 37 in. by 30 in. stroke as compared to 22 and 35 by a 32 in. stroke on the Chesapeake & Ohio. The driving wheels are 1 in. larger, or 57 in., and the combination gives a maximum rated tractive effort of 75,000 lbs. as compared with the 82,000 on the Chesapeake & Ohio design. The two boilers, however, are very much alike, both having 24 ft. tubes 2¼ in. in diameter, and a 78 in. combustion chamber, which brings the firebox back of the rear driving wheels and permits the securing of a good depth of throat. The number of tubes have been increased from 401 to 439, giving an increase of 536 sq. ft., the total being 6,554.6 sq. ft., as compared with 6,013 sq. ft. in the Chesapeake & Ohio engine.

The most novel feature of this locomotive is found in the use of separate exhaust pipes from each of the low pressure cylinders. It has been found that with the ordinary single exhaust pipe on Mallet locomotives, wherein the passages come together in the cylinder casting before entering the flexible pipe, there is a noticeable back pressure created by the exhaust from one cylinder backing up into the exhaust cavity of the other. Therefore in this case the exhaust is carried through entirely separate pass-



FRONT FRAMES ON 2-6-6-2 TYPE LOCOMOTIVES—C., M. & ST. P. RY.

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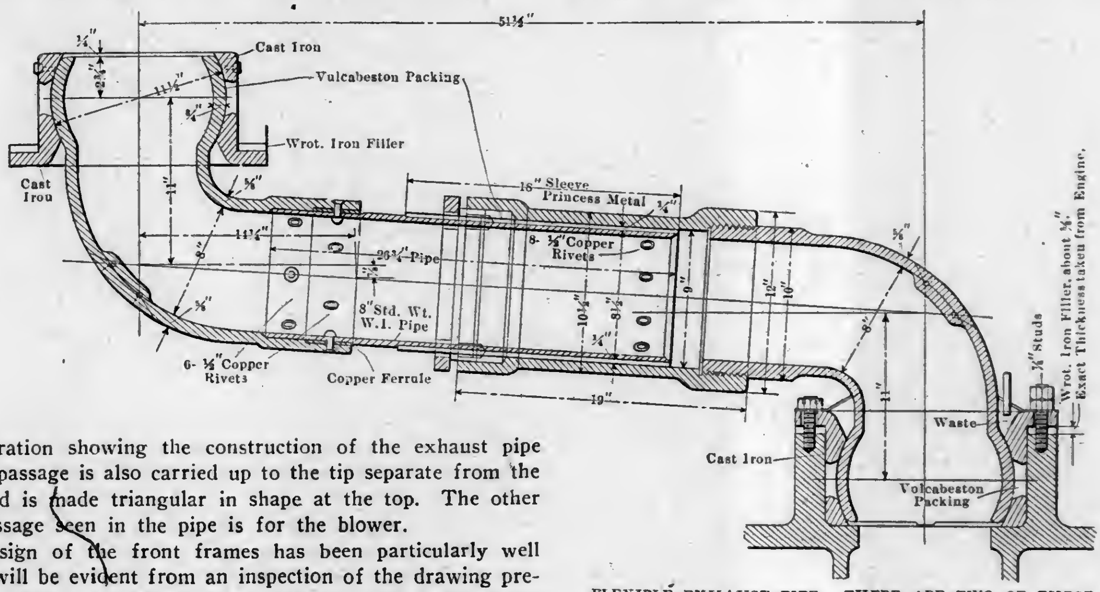
The design of the front frames has been particularly well done, as will be evident from an inspection of the drawing presented herewith. A particularly strong connection between the front rails and the main frames, as well as the connection between the cylinders and frames, are clearly shown. In cases of this kind where very heavy low pressure cylinder castings depend entirely upon the frames, not only to hold them in place, but also to carry the whole weight of the castings, this feature is one which can well be given most careful attention, as has evidently been done in this case.

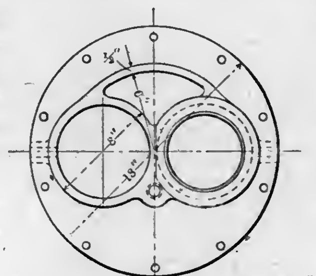
The trailing truck is of the De-Voy type, which has been adopted as standard on this system for all classes of locomotives using a trailer.

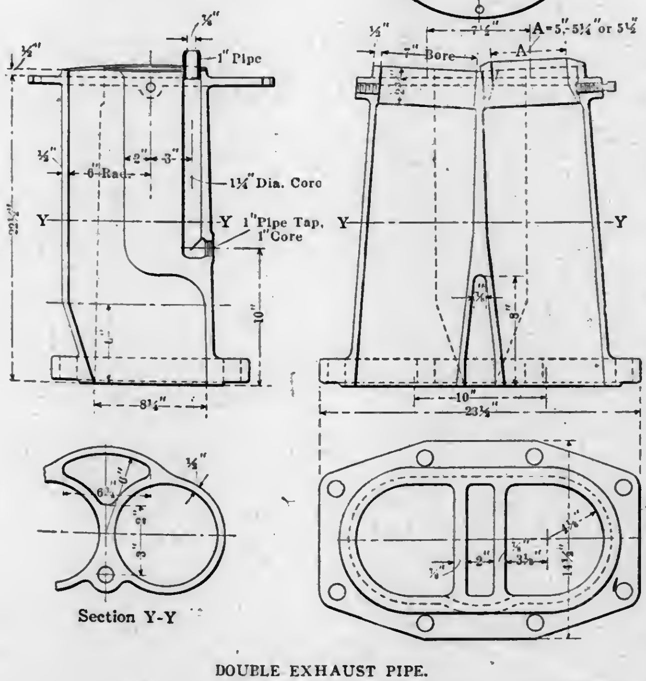
There is a slight difference in weight between the oil burner and the coal burning locomotives, due to the modifications required in the construction of the firebox, ash pan, etc., making the oil burners 2,500 lbs. lighter than those using coal, and giving them a total weight of 387,500 lbs.

The general dimensions, weights and ratios of the coal burning engines are given in the following table:



FLEXIBLE EXHAUST PIPE. THERE ARE TWO OF THESE ON EACH LOCOMOTIVE.





DOUBLE EXHAUST PIPE.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Maximum tractive effort	75,000 lbs.
Weight in working order	390,000 lbs.
Weight on drivers	323,500 lbs.
Weight of engine and tender in working order	555,700 lbs.
Wheel base, driving	30 ft. 6 in.
Wheel base, total	48 ft.
Wheel base, engine and tender	79 ft. 8¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.30
Total weight ÷ tractive effort	5.20
Tractive effort × diam. drivers ÷ heating surface	653.00
Total heating surface ÷ grate area	90.50
Firebox heating surface ÷ total heating surface, per cent	5.69
Weight on drivers ÷ total heating surface	49.30
Total weight ÷ total heating surface	59.50
Volume equivalent simple cylinders, cu. ft	22.80
Total heating surface ÷ vol. cylinders	288.00
Grate area ÷ vol. cylinders	3.18
CYLINDERS.	
Kind	Mellin Compound
Diameter	23½ & 37 in.
Stroke	30 in.
VALVES.	
Kind H. P	Piston
Kind L. P	Slide
Greatest travel	6 in.
Outside lap H. P	1 in.
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Inside clearance	5/16 in.
Lead	3/16 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	10 x 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	8½ x 14 in.
BOILER.	
Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	83¾ in.
Firebox, length and width	108 1/16 x 96¼ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-5", S. & B-4½ in.
Tubes, number and outside diameter	439-2¼ in.
Tubes, material and thickness	Char-Iron, No. 11 B. W. G.
Tubes, length	24 ft.
Heating surface, tubes	6,182 sq. ft.
Heating surface, firebox	372.6 sq. ft.
Heating surface, total	6,554.6 sq. ft.
Grate area	72.3 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 5⅞ in.
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

The ash pits, which are of the usual shovel type with the outer rail on the side wall, are located near the turntable as is customary and proper. The general plan of the whole shop shows the track arrangement and inter-relation of these various parts. A rest house and engine dispatcher's office forms an addition on the east end of the roundhouse structure.

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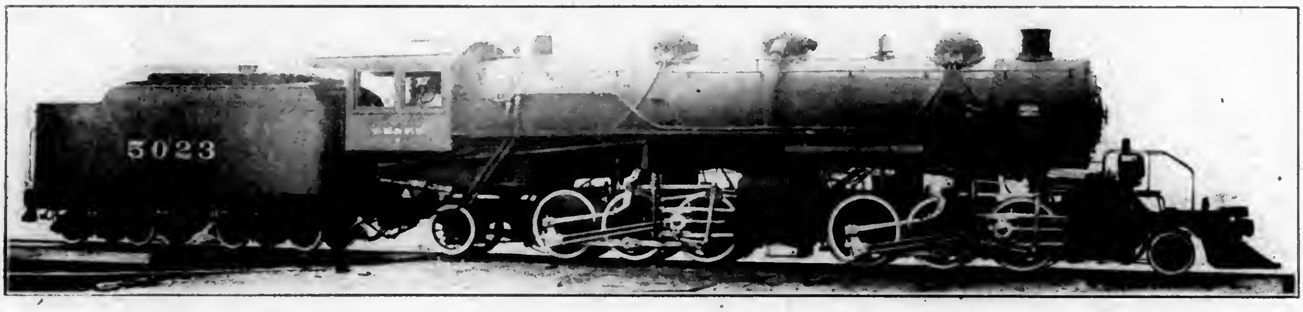

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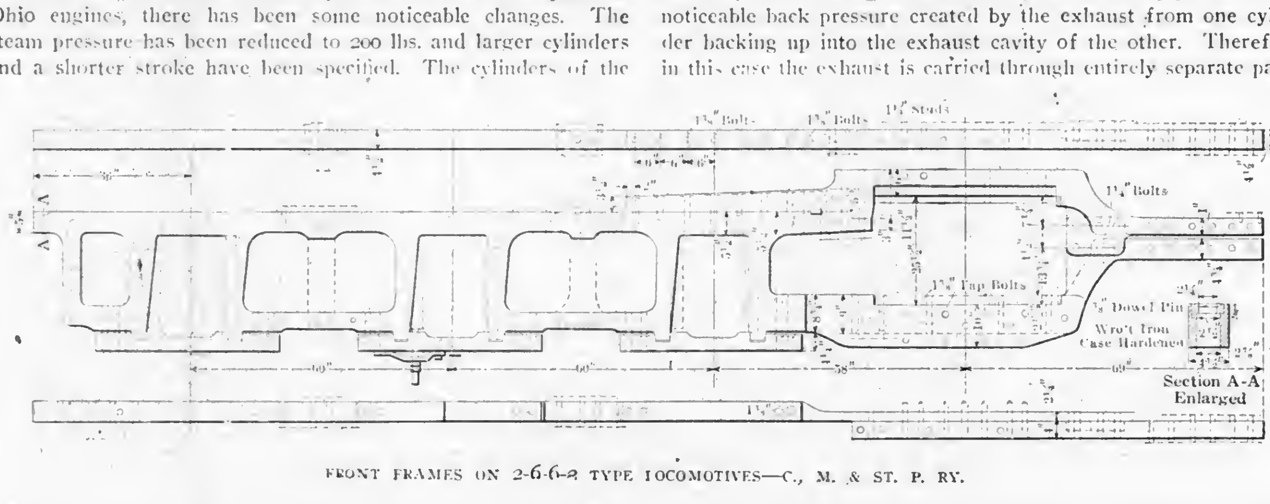

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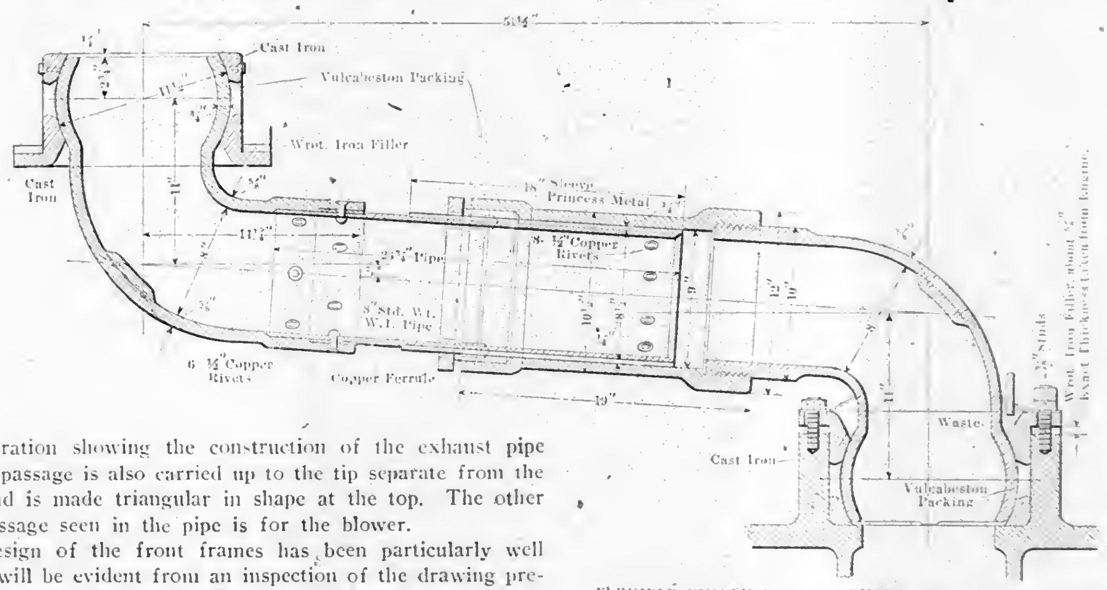

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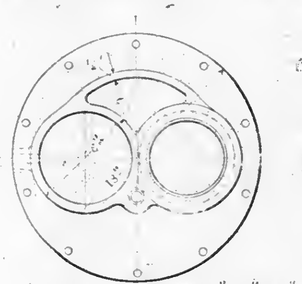

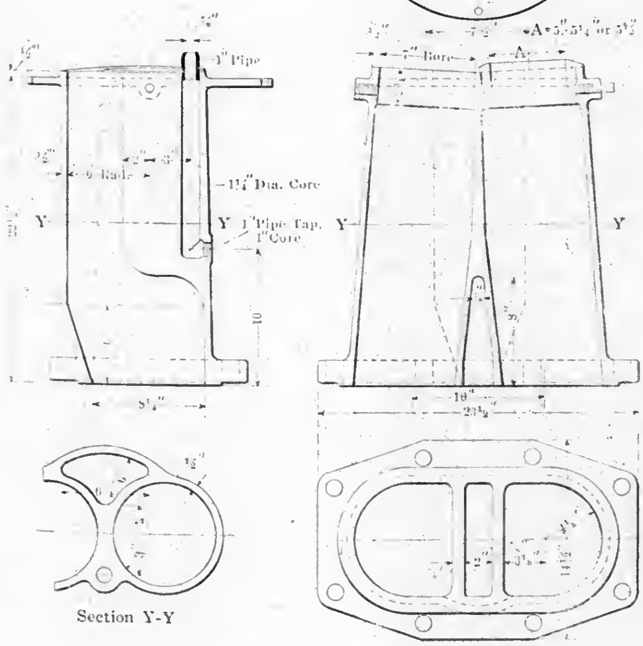

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EXTERIOR AND INTERIOR VIEWS OF PRIVATE CAR BUILT IN ENGLAND FOR SERVICE ON THE SOUTH MANCHURIA RAILWAY.

Luxurious Private Car for the Orient

THIS LATEST EXAMPLE OF BRITISH BUILT ROLLING STOCK IS FOR THE SOUTH MANCHURIA RAILWAY, AND IS OF PARTICULAR INTEREST IN VIEW OF THE MANY DISTINCTIVE AMERICAN FEATURES EMBODIED, AND THE SOLIDITY OF CONSTRUCTION, THE LATTER BEING SOMEWHAT UNUSUAL IN FOREIGN PRACTICE.

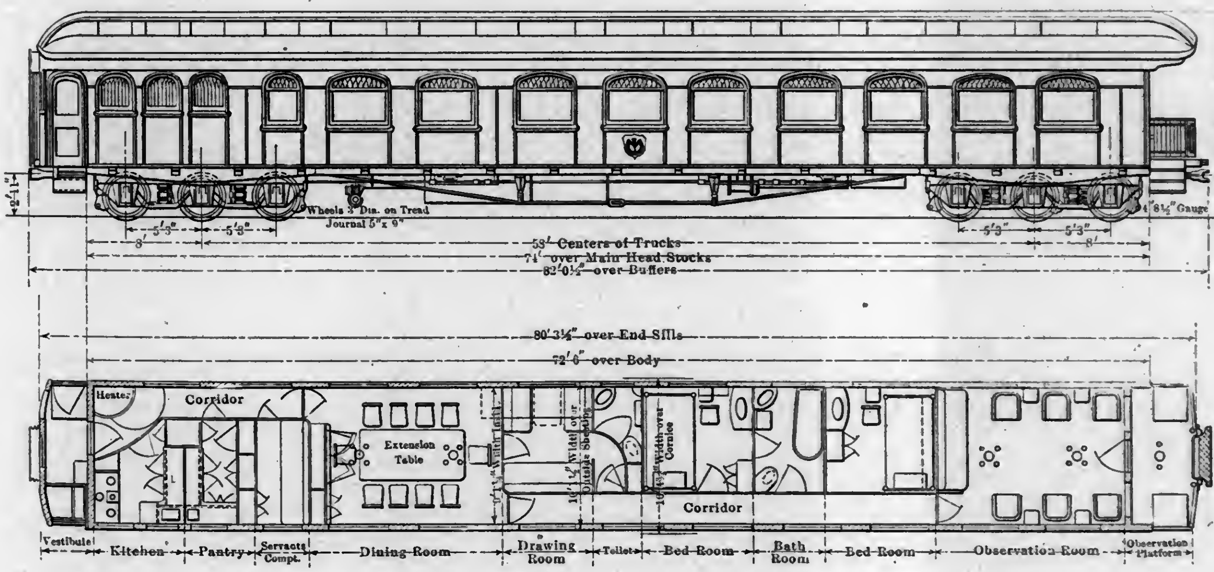
During the past few years the car builders of England have been working hard to secure a recognized position in the foreign field, and that their painstaking efforts have been rewarded with a measure of success is evinced through the many varied designs which of late have been evolved for the Russian and the various South American railroads. Recently the Leeds Forge Co., Limited, of Leeds, England, turned out a number of large and novel self-discharging hopper ballast cars for the Buenos Ayres Western Railway, and the order herein illustrated, which is of even greater interest, is that of an elaborate saloon car for the South Manchuria Railway, one which undoubtedly represents the most ambitious attempt to date on the part of English builders.

It will be noted that this car is representative of those privately owned on our American lines, and before proceeding with a description of its interesting details it may be well to mention that many departures from established English standards rendered its construction extremely difficult, and the fact that this was brought about in a way entirely satisfactory to the purchasers speaks well for the adaptability of the builders. Instead of the comparatively light design, which is conspicuous in foreign practice, they were compelled in this instance to contend with a car which in weight and general dimensions equals if not exceeds the dimensions established by practice in this country.

To this end it became necessary for the builders to make additions to their shop equipment, which heretofore had been entirely adequate to serve their needs, and to embody constructive ideas with which it may be assumed that they were not in entire sympathy. The drawings, of course, were furnished by the railroad company, and the car was built under a plan of purchaser's inspection, so exact in its requirements as to render any deviation from the latter's views a matter of sheer improbability.

The car which was constructed to the designs of M. Yoshino, chief mechanical engineer of the South Manchuria Railway, has a length of 80 ft. 3½ in. over the platforms; a width of 10 ft. over the side panels, and a height from the floor level to the underside of the roof of 9 ft. 8 in. The underframe is of steel throughout and of a most substantial design and arrangement. The body of the car is framed in teak strengthened by steel trusses and paneled on the outside with planished steel plates, the joints being covered by brass mouldings. The floors are double, with a space between packed with granulated cork. The roof is also double, with an air space between the inner and the outer roof, and is covered externally with prepared roofing canvas, the portion over the canopies being sheathed with copper. It will be noted that the trucks are of the 6-wheel type, with a wheel base of 10 ft. 6 in., and have triple coil anxiliary bearing springs, the main bearing springs being elliptical. The wheels have disc wheel centers with steel tires and axles, and the journal boxes are adapted for oil lubrication. The couplings and draft gear are the Buhoup three stem automatic type, with cast steel heads and knuckles and helical springs, and fitted with a special coupling device operated from the platform or vestibule. The car has the Westinghouse automatic air brake acting on all the wheels, and also an independent hand brake, this latter being worked from either platform by a patent ratchet brake handle.

The general plan of the car is as follows: At one end is an open platform, having a brass hand railing with gates of ornamental design, and which is furnished with curtains by which it can be closed in when required. The floor is covered with india rubber tiling and has a trap-door at each side which closes over the platform steps. Opening from this platform there is an observation room, furnished with lounge chairs and a large couch upholstered in morocco. The back of this couch is arranged to turn up to form a berth when needed, and there are also hinged tables placed in convenient positions. A corridor leads from this room past the various staterooms to the dining room. There are two bedrooms, each furnished with brass bedsteads, wardrobe, washstand, dressing table, etc., with a communicating bathroom and lavatory connected by doors with the two bedrooms. The drawing room is entered from the corridor and has two seats constructed to pull out at night to form a berth and with a couch placed against the partition



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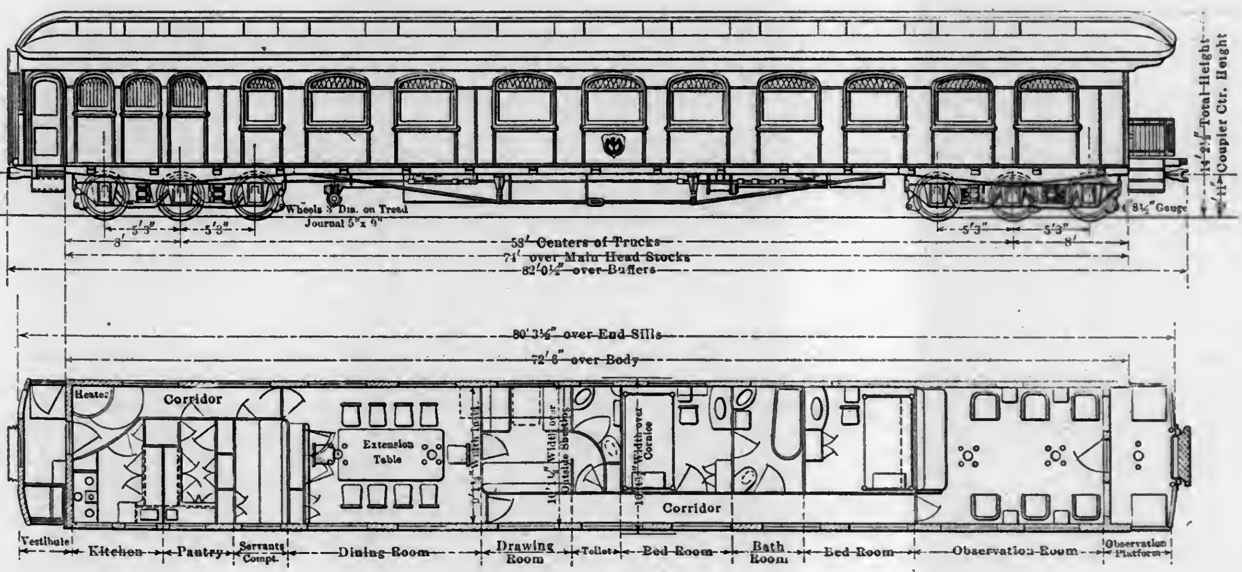
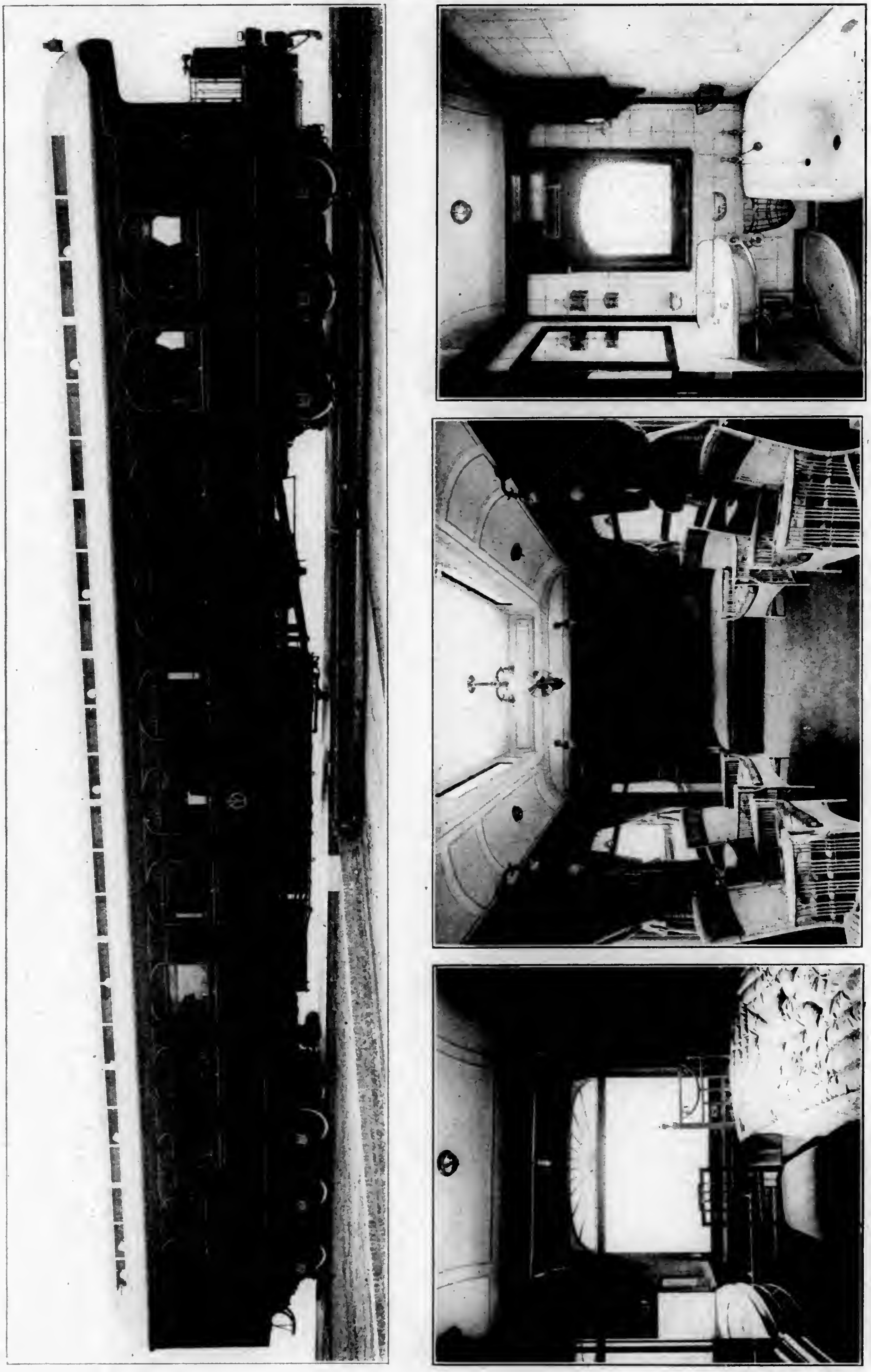
The general plan of the car is as follows: At one end is an open platform, having a brass hand railing with gates of ornamental design, and which is furnished with curtains by which it can be closed in when required. The floor is covered with india rubber tiling and has a trap-door at each side which closes over the platform steps. Opening from this platform there is an observation room, furnished with lounge chairs and a large couch upholstered in morocco. The back of this couch is arranged to turn up to form a berth when needed, and there are also hinged tables placed in convenient positions. A corridor leads from this room past the various staterooms to the dining room. There are two bedrooms, each furnished with brass bedsteads, wardrobe, washstand, dressing table, etc., with a communicating bathroom and lavatory connected by doors with the two bedrooms. The drawing room is entered from the corridor and has two seats constructed to pull out at night to form a berth and with a couch placed against the partition



ELEVATION AND FLOOR PLAN OF PRIVATE CAR FOR THE SOUTH MANCHURIA RAILWAY.



EXTERIOR AND INTERIOR VIEWS OF PRIVATE CAR BUILT IN ENGLAND FOR SERVICE ON THE SOUTH MANCHURIA RAILWAY.

Luxurious Private Car for the Orient

THIS LATEST EXAMPLE OF BRITISH BUILT ROLLING STOCK IS FOR THE SOUTH MANCHURIA RAILWAY, AND IS OF PARTICULAR INTEREST IN VIEW OF THE MANY DISTINCTIVE AMERICAN FEATURES EMBODIED, AND THE SOLIDITY OF CONSTRUCTION, THE LATTER BEING SOMEWHAT UNUSUAL IN FOREIGN PRACTICE.

During the past few years the car builders of England have been working hard to secure a recognized position in the foreign field, and that their painstaking efforts have been rewarded with a measure of success is evinced through the many varied designs which of late have been evolved for the Russian and the various South American railroads. Recently the Leeds Forge Co., Limited, of Leeds, England, turned out a number of large and novel self-discharging hopper ballast cars for the Buenos Ayres Western Railway, and the order herein illustrated, which is of even greater interest, is that of an elaborate saloon car for the South Manchuria Railway, one which undoubtedly represents the most ambitious attempt to date on the part of English builders.

It will be noted that this car is representative of those privately owned on our American lines, and before proceeding with a description of its interesting details it may be well to mention that many departures from established English standards rendered its construction extremely difficult, and the fact that this was brought about in a way entirely satisfactory to the purchasers speaks well for the adaptability of the builders. Instead of the comparatively light design, which is conspicuous in foreign practice, they were compelled in this instance to contend with a car which in weight and general dimensions equals if not exceeds the dimensions established by practice in this country.

To this end it became necessary for the builders to make additions to their shop equipment, which heretofore had been entirely adequate to serve their needs, and to embody constructive ideas with which it may be assumed that they were not in entire sympathy. The drawings, of course, were furnished by the railroad company, and the car was built under a plan of purchaser's inspection, so exact in its requirements as to render any deviation from the latter's views a matter of sheer improbability.

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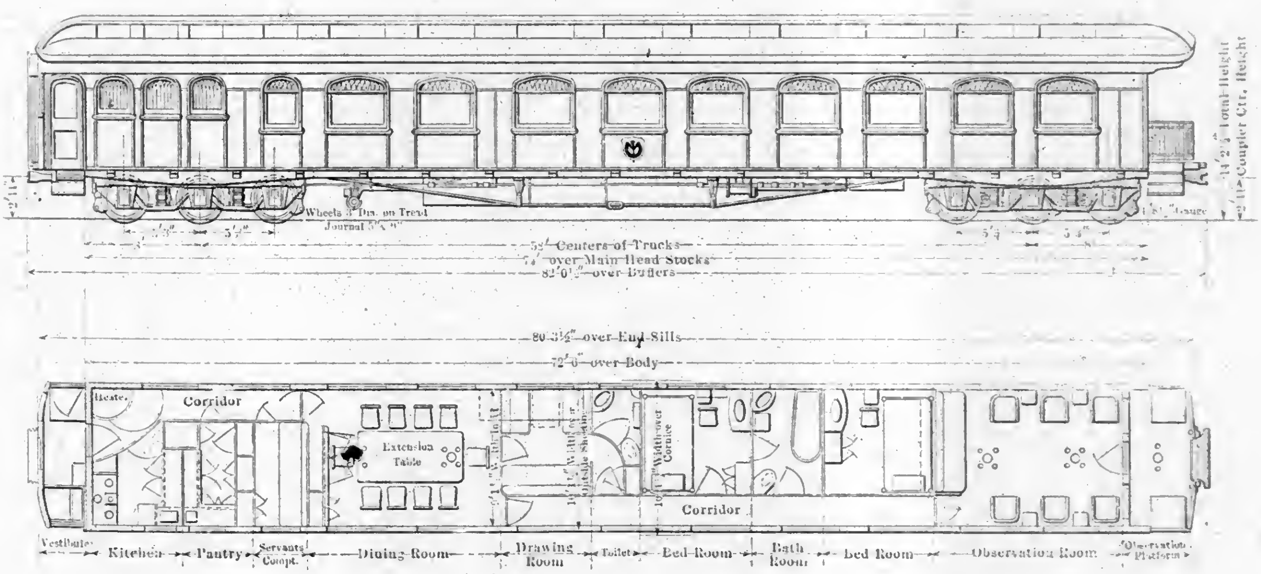

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Electric fans are fitted in all the rooms, and there is an exhaust fan in the kitchen. The dynamos and storage batteries are suspended from the underframe. Torpedo ventilators are fixed in suitable positions in the roof. The corridors are required when the car is standing. The heating pipes are carried through the various rooms and corridors, and are covered with brass ornamental grids; radiators are also placed in the main compartments. Provision is made for the supply of hot water to the bedrooms, bathroom and toilet room, from a tank fitted in the roof of the kitchen, heated from a boiler in the range, and kept supplied with water automatically by pressure from the air brake system. The main water supply is by two tanks suspended from the underframe. All the steam and water pipes are lagged with asbestos.

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An annealed steel is by far safer, although not always as strong perhaps. By "strong" I refer to elastic limit per square inch. It is safer, because if the annealing operation be properly conducted, all previous conditions of physical treatment have been obliterated, and a fixed predetermined condition established. A condition under control has been realized, and surely that is better than one not under control. The performance of a given quality of annealed steel may be predicted—its elastic limit, reduction of area, elongation and tensile strength. The arrangement and size of crystals are known, too, and this is the most important, as all physical results depend upon the condition of the crystals. A coarse-grained steel of any given quality will not break with the same good reduction of area as a piece in which the crystals are fine. Neither will the elongation be as good, but the reduction of area is most affected by crystal size. In other words, the reduction of area in a tensile test is the best single measure of grain size. The so-called "natural" condition of a bar of steel that is to be heat treated is of the utmost importance. If by chance the bar has been so forged or rolled and finished at a high temperature (say 1800 deg. F.) the grain of the steel will be coarse and the crystals shiney and "firey," so-called. This being the case, a simple toughening heat treatment carried on at proper temperatures (say 1500 deg. F.) will not refine this grain as it should. A double treatment becomes necessary, the first quench being at a high temperature (say 1725 deg. to 1750 deg. F.), followed by a lower quench at 1500 deg. F. or thereabouts; or a full anneal followed by a quench will answer the same purpose.

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the purchase of materials is service or endurance. The material giving most for value received is the best, whether it be in ton mileage or in years' service. The rail that wears best for a given cost in position to use is the cheapest. This is also true with an axle, a set of gears, a set of bearings or a set of rubber tires. In fact, some of these articles are actually paid for on a mileage basis.

Sometimes it is possible to buy this excellence in the crude material; sometimes it is better to create excellence by treatment, such as the seasoning of wood, the case-hardening or simple hardening of steel. Heat treatment is another illustration. It is often wise and economical to depend on a steel of low original cost and then treat it, as in case-hardening steel. Again, it is wise to buy a steel that is used in the condition purchased, and more often it is best to combine a medium cost of material with heat treatment.

It is thought by some that if a high priced alloy steel be purchased and used as purchased, that full value is thereby obtained. This is a mistake, as there is no alloy steel that will yield anywhere near the benefit that will compensate for the increased cost, without intelligent heat treatment at some stage of its adaptation for use. An alloy steel in a natural condition, or in an annealed condition, is but little better than a good plain carbon steel. In other words, 15 cent steel is but little better than 3 cent steel, unless it be developed physically by suitable treatment, as illustrated by the following figures:

RESULTS OF TESTS IN WHITE-SOUTHER ENDURANCE MACHINE.

Mark.	Elastic Limit per sq. in.	Fibre Stress Applied.	Endurance.
.40 Carbon Steel, "As received"...	59,800 lbs.	54,800	19,300 revs.
.22 Carbon Chrome-Vanadium, "As received" (1.00% chromium)...		54,800	46,900 revs.
.25 Carbon, 3.50% Nickel-"Natural"	55,400 lbs.	54,800	75,400 revs.
.30 Carbon, 3.50% "Heat Treated".	81,100 lbs.	54,800	10,814,000 (did not fail.)

Among the same line of reasoning, steels must be chosen in relation to the design, proportions and use of any given part. If a 3 cent steel will do a piece of work, then there is no reason for the use of a more expensive steel, whether the expense be in the original cost of material or the cost of treatment. If a factor of safety of ten exists and suffices, then a material that will give a factor of twenty is of no greater value. All forms of degrees of excesses are committed in the selection of steels along these lines. The poorest steel is put to uses and the best of results expected from it, where only the best should be used. Steels are used in a natural and uncertain state when the greatest certainty should prevail, and at other times are treated when a natural condition would answer all demands. In between these extremes lies the reasonable and economical course; the hardest to follow. Theory and practice must unite; laboratory tests and empirical knowledge must be used in combination. Design and materials must go hand in hand. Extremes are necessary at times, but certainly not as a rule. With a given procedure laid out extremes in manufacture must be avoided.

It is folly to adopt a material or treatment that requires the exactness of laboratory methods. Another choice would be better, and there is always more than one way to accomplish any reasonable and practical purpose. To measure a brick with a micrometer is no more foolish than to caliper a steel ball with a pair of calipers; and to measure a furnace temperature to a degree or five degrees is as impractical as to not measure it at all with ready means for doing so at hand. Common sense temperature measurements must be possible, or the practice had best be discarded for some other. No steels are so sensitive to heat treatment as to demand very close temperature measurement. There is always a fairly wide range of safe temperatures that will produce good results, and practical and uniform results. Twenty-five to fifty degrees are close practical limits, with one hundred to three hundred degrees sometimes close enough for certain alloys. It is a sad boast to hear that a shop is controlling all temperature measurements to five degrees. It is a waste of money if true, but usually it is not true.

The alloy steels available are already many, and new ones in sight. One good movement is a search for an alloy that will produce the best of results with the widest of temperature ranges. The narrow range alloys are to be avoided as much as possible. A list of structural steels available for all classes of work:

.10 to .20	Carbon Steel.
.20 to .30	" "
.30 to .40	" "
.40 to .50	" "
.50 to .60	" "
.70 to .90	" "
.90 to 1.10	" "
.20 to .30	Carbon, with 3.50 per cent. Nickel.
.30 to .40	" " " " "
.20 to .30	" with 1.00 per cent. Nickel, .50 per cent. Chromium.
.30 to .40	" " " " " " " "
.40 to .50	" " " " " " " "
.15 to .25	" " 3.00 " " 1.50 " "
.25 to .35	" " " " " " " "
.45 to .55	" " " " " " " "
.15 to .25	" with 1.00 per cent. Chromium, .15 per cent. Vanadium.
.25 to .35	" " " " " " " "
.35 to .45	" " " " " " "
.40 to .50	" with 2.00 per cent. Silicon, 1.00 per cent. Manganese.

and besides these many variations of them for individual fancy or peculiar usage. All may be improved by suitable heat treatment; many should not be used until heat treated.

The dominant elements of composition have been thus briefly stated. The other elements depend upon the process of manufacture as related to a reasonable cost. With the basic open hearth, crucible and electric furnaces, all carbon steels may be obtained at a low cost containing the objectionable elements of sulphur and phosphorus below .04 per cent., or, at the most, .05 per cent. Copper, the other objectionable element, need not exceed .10 or .20 per cent. in any steel. This is a matter of selection of raw stock for melting and it would seem from experience that amounts represented by the latter figure cannot be detected as far as bad results go except possibly (not positively), in welding operations. Silicon is not objectionable and is fully under control. It costs but little to include or exclude. To keep it within narrow limits seems wise for the sake of uniformity, say from zero to .25 per cent. Manganese is also under control and should be kept uniform for the sake of uniformity. This element affects the strength and toughness and responds to heat treatment to a marked degree. It is beneficial in proper proportions.

For railroad purposes, then, there is already this long list of alloys from which to choose. The problem is to choose that which will yield the most value for money expended, whether it be carbon steel or alloy steel.

Also, whether it will pay to heat treat, and to what extent, must be considered. To do this without concrete cases before one is not possible, but the scheme may be considered in a general way:

Roadbed: Ties, tie-plates, splice-bars, frogs and switches and bridges.

Motive Power: Driving axles, tires, connecting rods, crank pins, piston rods, frames, springs and boilers.

Rolling Stock: Wheels and brakes, couplings, axles and springs.

A railroad man, in considering the choice of steels for many purposes, has before him the well kept mortality records of the system. This information is invaluable, as it is the combination of successes and failures that give the empirical knowledge that completes and perfects the understanding of theory. A record of the lifework of a piece of steel and accurate data are the most powerful tools that an engineer has to work with. The scrap heap is the most instructive place about a plant in more ways than one. Knowledge gained there by an observer, with a combination of Sherlock Holmes' and metallurgist in his make-up, is the best kind of knowledge to be used for a future guide. It is a poor observer who does not benefit by careful study of any scrap heap.

In connection with the locomotive there is much detail that can hardly be handled by any one other than a railroad man. In a general way, a few parts will be touched on, and of these one part is the driving wheel tire. It is well known that driving wheel tires are an important element in a locomotive. They are called upon to withstand severe abrasive strains while the wheel is slipping and skidding; also heat as the result of locked wheels. They are now made, as a rule, of a high carbon steel

in the neighborhood of .7 per cent. carbon. They are naturally very hard to machine even when properly annealed. To heat treat this form of steel, high in carbon as it is, would be a hazardous operation, the tendency to break during hardening being very great in sections of circular form.

It would seem that an alloy steel, when heat treated, would give a much higher elastic limit than is possible with the material now used in a forged condition, would make a better tire. It would be stronger; that is, it would not crush or pene out as easily under the rolling action. That it would abrade less under skidding and slipping conditions is doubtful, and perhaps this is the most rapid cause of rapid wear of driving wheel tires. The fine grain resulting from heat treatment would make it more difficult to sprawl off small pieces. This has been fully proved by a miniature wheel rolling on a rail; that is, a roller or ball in a bearing. It has been amply proved that a coarsely crystalline roller or ball will not stand as well as one which is very finely crystalline; practically without crystals, so fine does the fracture appear. In the best ball or roller bearing the raceway upon which the ball or roller runs is of steel which, when hardened, gives the finest possible grain, as shown by a fracture.

Within the realm of practice there seems to be no good reason why the ideal condition between driving wheel and rail should not be the same; that is, an exceedingly fine grained path upon which an equally strong and fine grained tire should roll. It is well realized that large dimensions and unfortunate sections will not permit the use of exactly the same material for tire and rail as for relatively tiny roll and raceway, but it would seem that a lesson has been learned that might well be taken advantage of as far as possible. Skidding produces so much heat as to actually draw the temper and soften a tire, which may also quickly chill again from contact with the cold metal rail. This produces the well known hard spot of the locomotive tire.

This is mentioned, as it would have a strong influence on the choice of an alloy steel that might be used for a tire and the heat treatment to which it would be subjected. It would be folly to select an alloy which would be hardened, only to have it softened again by skidding. An alloy must be selected that will produce a fine grain and high elastic limit, and retain these characteristics even up to a red heat. Just how hot the tire becomes under skidding conditions is perhaps not easily determined, but if the heat does not exceed low reds (900-1000 deg. F.) then there are alloys which, when heat treated, will not be seriously injured (weakened) by such a temperature. There is not sufficient information available from which to draw practical specifications for such a purpose, but on general principles it would seem that .40 to .50 carbon nickel, chrome-nickel, or chrome-vanadium steel might fulfill this purpose, properly heat treated.

The heat treatment should consist of a thorough refinement of grain, coupled with such drawing temperatures as would leave the material in a strong but tough condition. If certainty of strength is an important element, then the heat treated alloy is safer than the forged carbon steel ring. In the driving axle of a locomotive is found a part that might well be made of a thoroughly heat treated steel. It is of large dimensions and has to be forged with several heatings, and if left in a natural condition, it is, necessarily, in a non-homogeneous condition. Homogeneity should exist in such an important part; in fact, it should exist in any axle.

It would seem that a driving axle properly designed does not need to possess a very high elastic limit, but it does need to be in a condition to resist vibration, fatigue and impact. This means that it must be fine grained. Stiffness must be secured by large dimensions, and such dimensions as will yield the necessary stiffness will usually yield more than enough strength; but if there be certain designs where space or weight is limited, then the alloy steel may be wisely resorted to in order to obtain a high elastic limit with very greatly increased powers of resistance to fatigue.

The question of cutting and wearing of a bearing is one of lubrication and the proper combination of metals. This is well illustrated by experience in connection with the automobile crank shaft. With the pressures used, it has been demonstrated by experience that the only safe steel to put against bronze bearing boxes is one that will become—either by hardening, as tools are hardened, or by creating a surface hardness, as with case hardening—as hard as tool steel. The ordinary hardness of steel, as annealed, or as toughened by heat treatment, will not stand up against any form of brass. Cutting takes place at once (the steel seeming to cut), lost motion follows and soon becomes excessive.

On the other hand, babbit of high grade does endure indefinitely against soft steel, as used in automobiles. This experience is true under exactly the same conditions of lubrication. Therefore lubrication cuts no figure in the foregoing experience. An alloy steel, therefore, may be wisely resorted to in the crank pin of the locomotive, if greater elastic limit is needed, or greater homogeneity be an important factor.

The connecting rod is another illustration of a portion of the locomotive that must be forged, and after forging naturally cannot be in a homogeneous condition. It should, therefore, receive some treatment after forging, either annealing or heat treating, the latter to be preferred, because of the greater strength obtained. The locomotive crank pin, like the axle, may be of such generous design, in order to get sufficient bearing surface, as to possess surplus strength. This being the case, there is no need of resorting to an alloy steel At the same time, it must be borne in mind that a crank pin forged from an alloy steel of the proper composition, and properly heat treated, is, without question, much more reliable than steel in any other condition.

If a connecting rod must be stiff, to withstand the "whip" of rapid reciprocating movement, possibly the design demands so much material that strength is not an important consideration. Under such condition, alloy steel is not necessary. On the other hand, if fatigue due to vibration be an important factor, then the fine grain of an alloy steel resulting from heat treatment becomes important. The piston rod is a part to which the remarks on connecting rods also apply; possibly to a less extent as to severe punishment. There is no question but what the piston rods should be made of homogeneous material, and therefore bettered by heat treatment. The problem is to ascertain whether or not a material of very high elastic limit is necessary.

The frame of a locomotive presents very different problems. It seems as if an easily forged, easily welded steel would be a most important consideration. If an alloy steel is chosen, it must be with these qualities in mind. The shape of the frame is irregular and will not permit easy handling for heat treatment. Annealing after forging is certainly desirable in order to bring the frame into a homogeneous condition with uniform grain throughout. That the sharp angles would withstand heat treatment is a question. If the treatment be a practical operation, the resulting benefit cannot be questioned. This problem is not unlike that encountered in the automobile frame, which is very thin, consequently, very sensitive to heat treatment. It is irregular in shape and difficult to handle. Nevertheless, heat treatment is carried on in a commercial way and with success. The most reliable frames and the strongest frames to-day are those of heat treated alloy steel. As far as locomotive frames are concerned, it is a question whether or not the benefits received warrant the extra cost of the material and the cost of heat treatment.

Springs, whether for locomotive or car, whether leaf spring or helical spring, are important. Exact knowledge of materials and treatment may exist, but it has not yet been put into practice in a widespread manner. Until the advent of the automobile, the manufacturer of springs followed along in the old ruts, almost undisturbed. His methods were good enough for the wagon and pleasure vehicle, and apparently good enough for railroad construction; otherwise, a railroad engineer would have stirred up just as much agitation as the automobile engineer has.

There was but one grade of spring material in common use; a carbon steel varying from .75 to 1.10 per cent. carbon, or thereabouts. The lower carbons within this range were used

for relatively light springs, and the higher carbons for the heavier springs. For the automobile other steels were suggested; possibly because it was found the European manufacturer used them.

Silicon steel, containing 2 per cent., more or less, silicon and .50 per cent. manganese, was found in many springs. This quality is sometimes referred to as "Silico-Manganese" steel, seemingly almost without warrant, as the manganese contained in much of it is no higher than the manganese contained in low carbon structural steel, for example. Carbon-chrome-tungsten steels are also used, as well as chrome-nickel-tungsten-vanadium and chrome-vanadium steels.

All of these steels when heat treated show an elastic limit very much higher than is possible to obtain with carbon steel, and at the same time retain a sufficient degree of toughness. The alloy steels easily yield an elastic limit of 200,000 lbs. per square inch, with a fine grain and a great degree of toughness. This elastic limit is obtainable with an alloy after drawing back at a temperature of 800 deg. F.; whereas a drawing temperature beyond 500 deg. F. or 600 deg. F., with carbon steel, lowers the elastic limit too much and gives a spring that is too soft, thereby causing it to set while in use. To be sure, the best has not yet been brought out of carbon spring steel, and will not be until improved methods as to uniformity obtain. An alloy steel turned over to the spring maker of the old school will certainly not make springs uniform in quality nor uniformly superior.

Springs are subjected to continuous alternate stress, and a fine grain is essential to a long life. Fine grain exists to a higher degree in the alloy steel than in the carbon steel, all other things being equal. Here, then, is an instance in railroad construction where alloy steel may be used to great advantage.

To use alloy steel in a boiler means practically, as far as can be seen at this time, that the steel would be used in a rolled or annealed condition, for the simple reason that the heat treatment of a boiler plate does not look like a practical operation at this time. Assuming the steel to be used in an annealed condition, then the improvement in elastic limit would be relatively small, and probably not great enough to warrant the extra expense. There would be some additional trouble in punching, reaming and drilling, and some additional power used in bending and forming.

Apparently, there is little to be gained from the use of alloy steel in the locomotive boiler. If there be a good opportunity, it must be in the stays and staybolts. These parts are subject to alternate stress. A tough alloy steel, treated to give the utmost toughness, ought to possess such characteristics as would endure under boiler conditions. A staybolt should be treated after threading. If treated before, then the fiber, or arrangement of grain, is disturbed by the threading—it is interrupted—and the bolt resembles a nicked bar, and is therefore more easily broken. If treated after threading, there is no serious disturbance or interruption in the continuity of the grain.

In car building the wheels are of much importance. With modern rolling processes a wheel may be made of any good forging steel. So far, it does not appear that they are heat treated commercially, nor that the use of alloy steels has been widely adapted. It does not appear that the industry demands a better wheel than that made from ordinary steel properly forged; but this is not saying that an alloy steel wheel, properly heat treated, would not be better. Consequently, with increased demands, it does not seem out of the realm of possibility that heat treated alloy steel wheels may become a commercial proposition.

As to car axles—as far as one may judge from the continuity of a given design that has endured for the last generation, it appears that there can be no great difficulty about the endurance of car axles. It is fairly good proof that the design and material satisfy the need. Many years ago Coffin brought forward the heat treated axle for cars and it certainly was an improvement. If the necessity arises, the heat treated alloy will be an improvement many-fold greater, but there is no necessity for using an alloy steel unless there be compensating benefit. That all car axles should be heat treated, it does not appear can be questioned at this time. Without such treatment the grain is coarse and fatigue rapid; with treatment the grain is fine and fatigue slow.

As already briefly stated, it is clear that the subject covered by the foregoing cannot be covered as well by one not directly connected with railroad engineering as by one who is. It may be that the outsider will look at the problem from a new and different angle; or, to put it another way, that the fool will rush in where angels fail to tread. If any new thought has been excited that may be followed up and lead to something really good; therein lies the excuse for what has been written.

DOUBLE TRACK MILEAGE

The proposal of the Harriman Lines to spend a vast amount of capital in double tracking their system, calls attention to the fact that there is a much smaller percentage of double track road in this country than is generally supposed. People who ride on the double and quadruple track lines in the Eastern part of the country are often unaware that more than two-thirds of the mileage of the country is single track. This statement includes 80,000 miles of siding.

Late returns of railway mileage shows that there is a total trackage in this country of 326,000 miles, of which 80,669 miles are sidings. There is 221,132 miles of single track and 20,637 miles of double track, 2,186 miles of treble track and 1,491 miles of quadruple track. Mr. Slason Thompson makes the following summary of track mileage covering the period since 1907:

Year.	Single Track.	Second Track.	Third Track.	Fourth Track.	Yard Track & Sid.	Tot. Mi. Oper. All Tracks.
1909 (94.4%) Bureau.	221,132	20,637	2,186	1,491	80,669	326,115
1908 official	230,494	20,209	2,081	1,409	79,452	333,646
1907	227,455	19,421	1,960	1,390	77,749	327,935
1906	222,340	17,396	1,766	1,279	73,760	317,083
1905	216,973	17,056	1,609	1,215	69,941	306,796
1904	212,243	15,824	1,467	1,046	66,492	297,073
1903	205,313	15,681	1,303	963	61,560	283,821
1902	200,154	13,720	1,204	895	58,220	274,195
1901	195,561	12,845	1,153	876	54,914	265,352
1900	192,556	12,151	1,094	829	52,153	258,784
1899	187,543	11,546	1,047	790	49,223	250,142
1898	184,648	11,293	1,009	793	47,589	245,333
1897	183,284	11,018	995	780	45,934	242,013

The table shows that where there has been an increase of only 50,798 miles of single track, or 27.7 per cent., in twelve years, all trackage has increased over 98,000, or 42 per cent., during the same period. It also shows that during the same twelve years second track has increased 87 per cent.; third track 120 per cent.; fourth track 91 per cent., and yard track and sidings 76 per cent.

LOCOMOTIVE SMOKE PREVENTION

In connection with the exhaustive inquiry into smoke prevention in the city of Chicago, as presented by Paul P. Bird in a paper before the Western Society of Engineers on February 15, the author makes the following timely observations on the proportion which the smoke emitted from locomotives bears to the general nuisance:

"Locomotive smoke carries with it quantities of sparks and cinders, while in stationary plants relatively little of such material is thrown out. This is because of inherent features in the design that are unavoidable. On a locomotive there is so little room available that the grate surface of the boiler is necessarily small and consequently a powerful draft is necessary to do the required work. This draft is obtained by discharging the exhaust steam from the engine cylinders up the stack. Because of this strong draft great quantities of fine coal and ash is drawn out of the firebox with the smoke, which in turn are discharged from the stack in the form of cinders. From 8 to 18 per cent. of all bituminous coal put into locomotive fireboxes escapes from the stack in this manner. In Chicago about 5,600 tons of coal are burned in locomotives each day. Assuming that 10 per cent. of the coal leaves the stack in the form of cinders, it means that 560 tons of cinders are thrown into the air and dropped on the city of Chicago every day. This is equal to about 14 carloads.

"On the other hand, in stationary plants where there is plenty of room for a larger grate surface and where the coal is burned with a lower draft and with tall chimneys, but few cinders are carried out with the smoke. Therefore the smoke from locomotives on account of carrying with it sparks and cinders is far more objectionable than the smoke from stationary plants, and as it is discharged into the atmosphere at no great distance from the ground and is trailed over long courses, it is safe to say that from the standpoint of a nuisance the steam locomotive is the worst offender of all. The investigation shows that the locomotives of Chicago make about 43 per cent. of the total smoke. Considering its character, the conclusion seems warranted that steam locomotives produce over one-half of the dirt traceable to smoke.

"The lowest percentage of smoke density made by the locomotives of any railway was 10.7 per cent. Probably 10 per cent. is as low an average as can be maintained with steam locomotives using soft coal. Therefore the very best condition that can be hoped for in Chicago is to have all locomotives average 10 per cent. density, which would mean that the locomotive smoke would still be 29 per cent. of the total, and probably be responsible for over one-third of the dirt. The modern steam locomotive is such a highly developed machine that it is extremely unlikely that any change will ever be made in its construction which will produce better results than this. A further reduction of the smoke made by locomotives can only be brought about by change of fuel. The possible fuels besides the local soft coals are semi-bituminous coal, anthracite coal, coke and oil. A considerable amount of semi-bituminous or Pocahontas coal is now being burned by some of the railways in Chicago, and although it makes less smoke than Illinois coal under the same conditions, its use by no means guarantees the entire elimination of smoke. Probably the universal use of semi-bituminous coal would not succeed in reducing the average density of smoke below a point that is considered possible with Illinois coal.

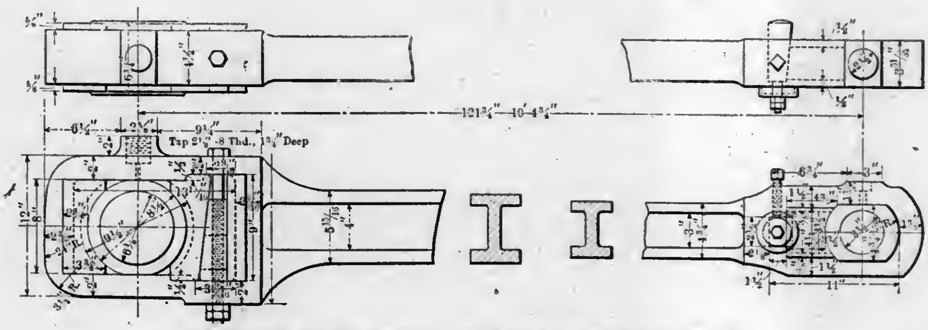
"The general use of anthracite coal or of coke for locomotives would eliminate smoke, but the other nuisances due to steam locomotives would not be diminished. If coke were used there would be an increase in the quantity of sparks and cinders discharged from the stacks. In either case the volume of furnace gases and their effect in vitiating the atmosphere would not be reduced. Fuel oil makes smoke unless carefully handled, and the smoke that is made is more objectionable than the smoke from soft coal. It is probable that if all locomotives in the city burned oil, the smoke and gases would form more of a nuisance than the soft coal smoke of to-day. The general use of any specially selected fuel would greatly increase the cost of fuel to the railways, and the practical difficulties involved would make it a very difficult thing to bring about. The locomotive fireboxes would have to be changed if coke or hard coal were used. In order to insure that all locomotives operating in the city limits used the same fuel, all the engines on an entire division would have to be thus equipped, which of course would greatly increase the cost of operation."

It is suggested by the author that general electrification within the city limits offers the only final and satisfactory solution for the smoke problem, and this, of course, is obvious, but in view of the fact that the locomotive contribution appears to be, from Mr. Bird's deductions, but 43 per cent. of the total, it would hardly appear as fully consistent to assume an expense in Chicago of some $30,000,000 with the knowledge that only one-half of the nuisance will be abated. The above quoted portion of the paper, however, is of exceeding interest in its comparison between the gravity of the objectionable features as contrasted between locomotives and stationary plants.

Experience has shown, and it cannot be denied that a small portion of smokeless fuel placed ahead on the tender, to be used while within the city limits, affords the most economical if not a fully satisfactory solution to the problem, as far as road engines are concerned. It is a question indeed whether it is really as grave as pictured, but at all events, as has been said before, it should not entail the heavy burden of electrification on railroads for the purpose of smoke prevention alone.

MAIN ROD WITHOUT STRAPS OR BOLTS

To guard against the liability to serious accident which is always present in the instance of broken straps, or even keys and bolts, the Chicago and Northwestern Ry. is experimenting with a new design main rod, in which through an ingenious and decidedly practical arrangement these familiar parts have



SOLID END MAIN ROD ON CHICAGO & NORTHWESTERN RY.

been effectually dispensed with. The new rod on which patent has been applied for by C. Markel, a shop foreman on that road, is being tried out on a modern freight engine in hard service. It is said to be entirely satisfactory, and in particular from the standpoint of maintenance.

The details of its construction are shown in the accompanying drawing. It will be noted that steel filling blocks are used in the back end. These are fitted to the opening in the rod, and are bored to fit the two half circle pieces of brass.

These latter are turned up on a mandrel and are simply planed top and bottom to keep them from turning in the rod. On account of being practically all lathe work the brass is simple and cheap to make. It has no flanges to break, which is a common occurrence on those of the usual design, and on many roads the cause of a very large number of renewals.

The arrangement under consideration is made to hold the liners in place by one inch flanges on the steel filling blocks. The latter, and in fact, all parts of this rod, are made to jigs and are interchangeable. A special chuck is used to hold the filling blocks while being bored out, and also a special mandrel to hold the bushings while being turned to diameter.

The front end brass to this rod is also turned, instead of the usual planed and hand fit brass. The brasses are finished for stock, with the exception of the bore for the pin fit, which implies very quick and cheap repairs in comparison with the cost of renewing these parts in the main rod of ordinary design.

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BOILER INSPECTION LAW

In view of the provisions in the previous bills proposed, there are many features in connection with the new Federal locomotive boiler inspection law that will be viewed with satisfaction by the motive power departments. For one thing it permits any road to have uniform boiler inspection throughout its lines instead of being subjected to as many different rules and requirements as there are States traversed. Again, it permits a flexibility of required inspections so that they can be suited to the conditions in various parts of the country, and in the third place it places the responsibility of inspection upon the railroad itself and not upon a government inspector. The government inspectors are, however, given ample authority to protect every decision and will be by no means mere figureheads, but on the other hand the railroads are well protected from unjust action.

It is required that each railroad shall file its boiler inspection rules for approval with the Commission and that upon such approval these rules shall become obigatory on each carrier. It is, of course, understood that the rules as approved are in the form of minimum requirements and that each company can make them more stringent if it desires. It would, therefore, seem advisable to have a united action of all companies for the purpose of adopting certain rules for boiler inspection, which would act as minimum requirements for all and could be easily adapted to the special conditions in each case. A movement with this in view has already been taken by the Master Mechanics' Association. The committee on boilers has already prepared a proposed set of rules for boiler inspection, that are universally applicable as minimum requirements. It is strongly urged that the different roads adopt these rules on that basis and submit them for approval to the Interstate Commerce Commission, as required by this law. These rules are in such form as to be suited, without alteration, to a great majority of the railroads and to those few which require greater care and more frequent inspection they can be easily altered to suit. If uniformity in this matter can be brought about by these means it will not only be of great assistance to the Interstate Commerce Commission in rendering decisions and orders after the law has been in operation, and appeals are presented to it, but in many cases it will mean that injustice and hardship to the railroads will be avoided.

GROUPING OF SHOPS IN ONE BUILDING

The placing of all the shops of a locomotive repair plant in one large building, as has been done at the Brewster shops of the Wheeling & Lake Erie, has advantages, particularly in a small shop where the erecting and machine shop cranes are not used to their full capacity and can satisfactorily serve the blacksmith and boiler shops as well, but from an operating standpoint it is probable that few shop superintendents will advocate this arrangement. It is the blacksmith shop that is the source of greatest annoyance, and even though down-draft furnaces and the greatest refinements in blowers, exhausters, etc., are employed, it is impossible to prevent the obnoxious gases and smoke from escaping and diffusing throughout the whole building. An atmosphere thus polluted is not only disagreeable and unhealthy, but also tends to corrode the bright work on machines and tools and to reduce the value of the excellent natural lighting now generally provided in machine shops. The boiler shop is not as bad an offender and very often the convenience of common crane service with the erecting shop more often offsets the objectionable smoke and noise, especially at points where heavy boiler work is comparatively infrequent. While there is no particular objection to doing the tender work in the same building with the erecting and machine shop it would seem better to have it performed in a separate structure located near the entrance track to the shop.

Of course, on this subject it is foolish to attempt to lay down any set rules to govern all cases and these features can be de-

termined only after a thorough understanding of the local conditions. In spite of this, however, it would seem advisable, irrespective of the size of the plant, to locate the blacksmith shop in particular in a separate structure from the other shops, or at least to separate it off with partitions, and also, if possible, to have the boiler shop by itself.

HEAT TREATMENT OF ALLOY STEELS

In connection with the interesting and very valuable paper by Henry Southers on Alloy Steels for Railroad Use, which appears elsewhere in this issue, there is much food for thought on the general question of the application and treatment of this material, and it is doubtful indeed if any previous contribution on the subject has dealt with it so comprehensively within the somewhat narrow confines to which the author has limited his analysis in this instance.

The importance of the consideration as applied to locomotives can scarcely be overestimated. As pointed out by Mr. Southers, through the entire gamut of driving axles, tires, connecting rods, crank pins, piston rods, frames, springs and wheels, no single item can fail to be benefited in increased strength and toughness by heat treatment properly applied. A heat treated steel is a closer knitted steel; there are fewer cleavage planes, and less chance of progressive fissures and rupture, qualities which are much sought after by all users of metals carrying live loads. The impression is entertained by many that if a high priced alloy steel be purchased, and used as purchased, that full value is thereby obtained. The author of the paper, however, points out this belief as erroneous, in view of the fact that there is no alloy steel that will yield anywhere near the benefit that will compensate for the increased cost, unless it receives intelligent heat treatment at some stage of its adaptation for use, and that an alloy steel in a natural condition is but little better than a good plain carbon steel.

In his advocacy for the alloy steels in locomotive parts Mr. Southers deals with the subject at some length and in a manner most convincing. That portion in particular where the driving tires are taken under consideration presents a remarkably sound and strong argument in favor of this material, and the same reasoning is followed with equal consistency through the remaining locomotive details. Throughout the views presented the fact is made clear that the universal use of alloy steel is not advocated in this construction, and in fact is not necessary where the design of the parts becomes of such generous proportions that the full factor of safety is assured.

The paper bears the impress of careful study and preparation and, needless to add, of absolute familiarity with the subject. It will without a doubt stimulate new thought on a subject which has not received its full measure of consideration, and possibly from unfamiliarity with many features in connection therewith on which this interesting paper now throws much additional light.

ABUSE OF PLATE IN BOILER SHOPS

There was a very exhaustive discussion several years ago about the danger of flanging or working on steel when it was at the brittle temperature, and so much was said and written on the subject at the time, together with the notice taken by the Railway Master Mechanics' Association, that it was supposed all railroad boilermakers had stopped the practice. Repeated observations since that time, however, convince us that foreman boilermakers are not even aware that there is any particular danger in working steel at its brittle temperature, or even that there exists a brittle temperature.

While it is not expected that working boilermakers should know the science of their business, the foreman certainly ought to know that hammering a sheet when it is at a brittle temperature is sure to produce bad effects and ought not to be permitted. This also recalls the fact that hand flanging of boiler sheets is not by any means obsolete. More than one road now prominently in mind is absolutely devoid of a flanging press, and doing practically all of its heavy boiler repair work without outside assistance. There is not much room for dispute in the assertion that when this work is done in a hydraulic press the operations are so quickly performed that the sheet is in no danger of falling below the proper temperature. If a railroad company cannot afford to purchase a suitable press, those in charge should have their flanging done in a shop equipped with modern boiler making appliances.

It at times occurs to us that master mechanics and general foremen might watch the rough practices of the boiler shop to rather more advantage than they do. One of the immediate resultant effects would be a decreased number of boilers with cracked sheets. The fact is, however, that the demand for hurried output of work is responsible for a great deal of the inferior boiler making practices which cause so much trouble and annoyance to the men handling and caring for locomotives.

FOREIGN SUPERHEATER INVENTORS ACTIVE

The superheat question in foreign countries is at present in the throes of a most extraordinary development, one which, to say the least, is not devoid of certain features almost akin to absurdities. Innumerable patents have been granted and applied for, and some of these designs represent the acme of what may be safely called, from a practical standpoint at least, freakish ingenuity. That they are ingenius must be conceded, and also that they might serve the purpose for which intended, but their complication is such that the actual construction would prove a serious problem, to say nothing of inaccessibility so far as regards maintenance.

Although the majority of these weird devices will never outlive the paper stage, there is still no doubt but that a few of them at least will attain to an actual existence on a locomotive. The management of railways on the continent of Europe are courageous experimenters, which fact is well borne out by a review of the varied boilers, cylinder arrangements and valve gears which are now being so extensively tried out. They will take hold of the superheater with even greater avidity, as it is recognized in Europe as in this country as one of the liveliest subjects in the locomotive world.

Experimenting as conducted abroad is on a most elaborate scale. If a device survives the exhaustive tests which are invariably accorded it, and becomes incorporated into the practice of the road conducting them, then it can be safely credited with the possession of unquestioned merit. Should it, on the other hand, fail, it is equally safe to assert that it will never be heard of again from the same quarter. Along this line the suggestion may be to the point that it would be well for American motive power management at large to keep in closer touch with what is going on abroad than has been their practice heretofore. It may not be that anything will be learned thereby, but much at least can certainly be saved through taking advantage of these foreign experiments.

We regard the present superheat test on the London and North Western Railway as one of the most important which have been run anywhere in recent years. A superheat and a non-superheat engine of equal dimensions were constructed especially for these experiments, and the results therefrom will determine the question of superheat as a principle, so far as that railroad is concerned. Furthermore the data will be so complete that it must be conclusive, and whether influential or not, it must prove of unusual interest to users of locomotives all over the world. In this instance the superheater is quite similar to the Schmidt, which has achieved such decidedly good results in this country and on the continent of Europe, but in reviewing the North Western results it would be well not to neglect the freaks also. There will be enough of them in use abroad before long to create instructive entertainment, to say the least, even if endorsement is not compelling.

2-6-6-2 Type Locomotives with Articulated Boiler

ATCHISON, TOPEKA & SANTA FE RAILWAY.

AMONG 40 MALLET LOCOMOTIVES RECENTLY COMPLETED BY THE BALDWIN LOCOMOTIVE WORKS FOR THE ATCHISON, TOPEKA & SANTA FE RAILWAY TWO WERE FITTED WITH FLEXIBLE OR ARTICULATED BOILERS, ONE HAVING THE BALL AND SOCKET JOINT AND THE OTHER A BELLOWS TYPE OF CONNECTION.*

In 1909 the Santa Fe received from the Baldwin Locomotive Works four Mallet compound locomotives; two of these were of the 4-4-6-2 type with 73-in. drivers and were intended for passenger service.† The other two were of the 2-8-8-2 type with 63-in. drivers for the heaviest class of freight service.† Experience with these locomotives, together with the service of nearly 150 fast freight engines of the 2-6-2 type, which have been in use since 1902, has led that company to place an order with the Baldwin Locomotive Works for 40 Mallet locomotives of the 2-6-6-2 type. At its own shops in Topeka the company combined two of the Prairie type freight engines into a Mallet for experimental purposes and is now engaged in converting 14 of the same type into Mallets by the addition of complete new front units.

* Record No. 69 recently issued by the Baldwin Locomotive Works is given up to a description of these designs.
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Of the 40 from the Baldwin Locomotive Works two are provided with flexible boilers—each having a different arrangement at this point, one being on the ball joint principle and the other with a bellows arrangement. With the exception of the arrangement of the superheater and reheater and the necessary changes in the steam pipes, these locomotives are the same as those with the rigid separable boiler. The engines have 24 and 38 by 28-in. cylinders, 69-in. drivers, carry 220 lbs. of steam and are fitted for burning coal. The theoretical tractive effort is 61,500 lbs. working compound. They all have the Jacobs-Schupert firebox and Buck-Jacobs superheaters and reheaters.‡

The 38 locomotives with rigid boilers have two steam domes on the evaporative section of the boiler, in addition to an auxiliary dome for safety valves and whistles. Twenty-eight of the locomotives have a straight type of boiler and 10 of the

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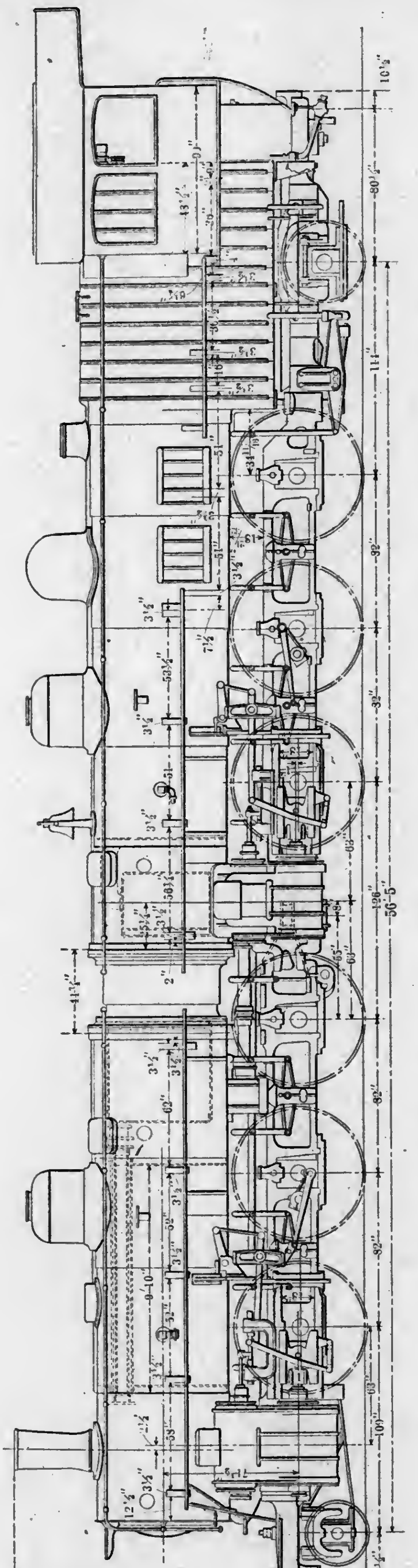
2-6-6-2 TYPE LOCOMOTIVE WITH RIGID SEPARABLE BOILER.

LOCOMOTIVE WITH BELLOWS TYPE ARTICULATED BOILER.

LOCOMOTIVE WITH BALL JOINT TYPE ARTICULATED BOILER.



GENERAL ELEVATION OF LOCOMOTIVE WITH BALL JOINT TYPE OF ARTICULATED BOILER AS DESIGNED BY THE BALDWIN LOCOMOTIVE WORKS.

conical. Experience with this type of firebox and boiler has shown the desirability of taking the steam from a point as near the firebox as possible, and since it was desired to have an external steam pipe between the throttle and superheater two domes were employed. The forward one, however, is simply a throttle chamber and is separated from the boiler by a horizontal plate. The steam enters the rear dome, passes through a piece of netting which assists in catching the suspended water, and is then conveyed forward through two 5-in. pipes to the forward dome, where it enters the throttle valve. This valve is designed to take steam from the top only. The dry pipe then passes out through the front of the dome, and has a flange which is riveted to the dome on the inside, the joint being made tight by a copper gasket. This pipe is fitted with a slip joint and leads forward along the top center line of the boiler, entering the superheater at a point just ahead of the separable joint in the boiler shell. This combined superheater and reheater occupies the full section of the boiler shell at this point and therefore the entrance to it is made through a ground joint on the top of the shell. The steam on leaving the superheater passes out through two pipes on the underside of the boiler shell and is conveyed back to the high pressure steam chest. These pipes are fitted with slip joints with packed glands and are arranged to be easily separated since they pass the separable joint of the boiler. The exhaust from these cylinders passes through similar pipes to the bottom of the reheater and after passing through this enters the flexible receiver pipe, which has a vertical slip joint connection with the steel casting reinforcing the bottom of the reheater outside the boiler shell and a ball joint just beyond the elbow. There is, of course, the usual ball joint at the low pressure cylinders and the arrangement of pipes at this point is the same as previousy used by this company.

Ahead of the reheater there is a combustion chamber with the manhole in the top center line of the boiler and ahead of this is the feed water heater, which occupies the full section of the boiler shell and has 340 2¼-in. tubes, 7 ft. 8 in. long, giving a heating surface of 1,516 sq. ft. The superheating surface is 300 sq. ft. and the reheating surface 650 sq. ft.

The high pressure cylinders are independent castings bolted to the double front rails of the rear frame. The valves are 13 in. inside admission piston valves with cast iron bodies and L shaped packing rings sprung on. The cylinders are placed 88 in. between centers and the steam chests are at 100 in. centers, which permits the Walschaert valve gear to all be placed practically in the same vertical plane. Since the main rods are connected to the second pair of wheels a very compact arrangement of valve motion has been designed, with the link and reverse shaft mounted on the guide yoke. The low pressure cylinders are also independent castings bolted either side of the steel box casting, which constitutes part of the front frame system, this being the usual construction of these builders. A compressed air power reversing mechanism is used, being of the Ragonette type, which has been applied to a large number of Mallet locomotives, usually, however, operated by steam.

In respect to the frames, which are of steel, the arrangement of the articulated joint and other features, these locomotives present no novelties. In accordance with the latest practice of the builders the vertical hanger bolts customarily used at the articulated connection for equalizing the loads on the front and rear frames have been omitted and the rails of the rear frame are extended forward between the upper and lower rails of the front frame and a slight amount of vertical clearance is provided. Any transference of load at this point is then effected by actual contact between the frames.

It is the two locomotives fitted with flexible boilers that present the source of greatest interest. The long overhang of the rigid boiler on sharp curves of course disturbs the center of gravity of the whole locomotive decidedly and increases the clearance in some cases to a considerable extent. It has, therefore, been thought advisable by the Santa Fe to experiment with the possibilities of a flexible boiler in which the front section would be rigidly attached to the front group of frames and move with them. This joint is placed in the combustion

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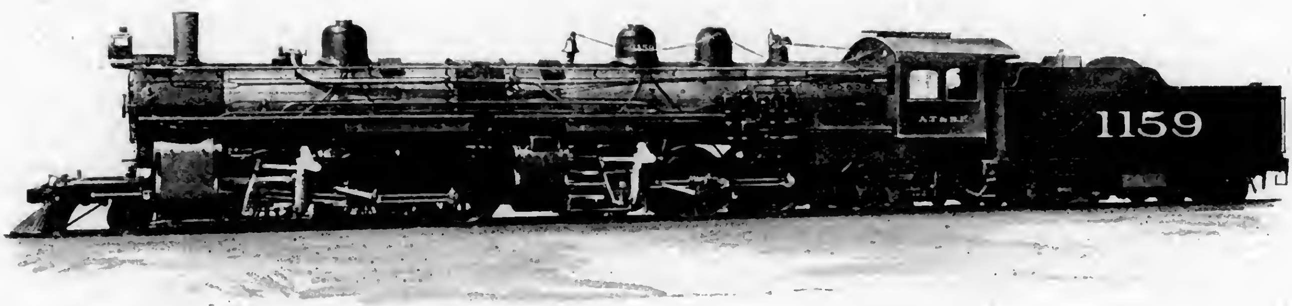

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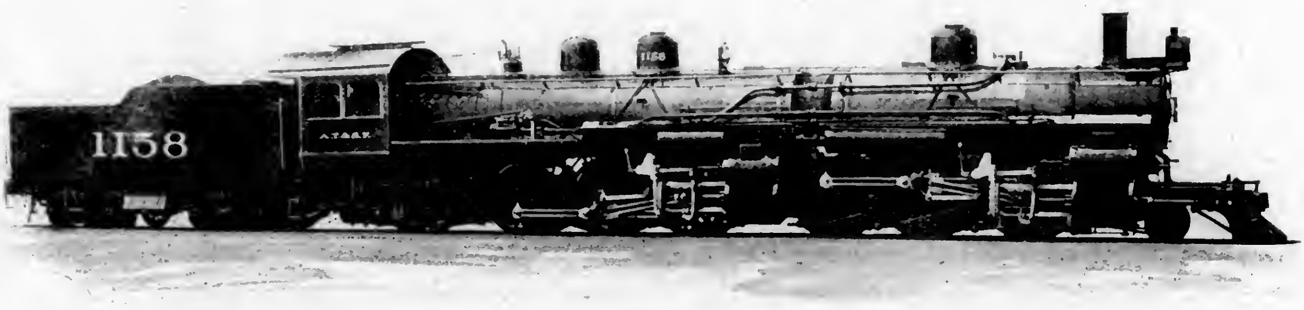

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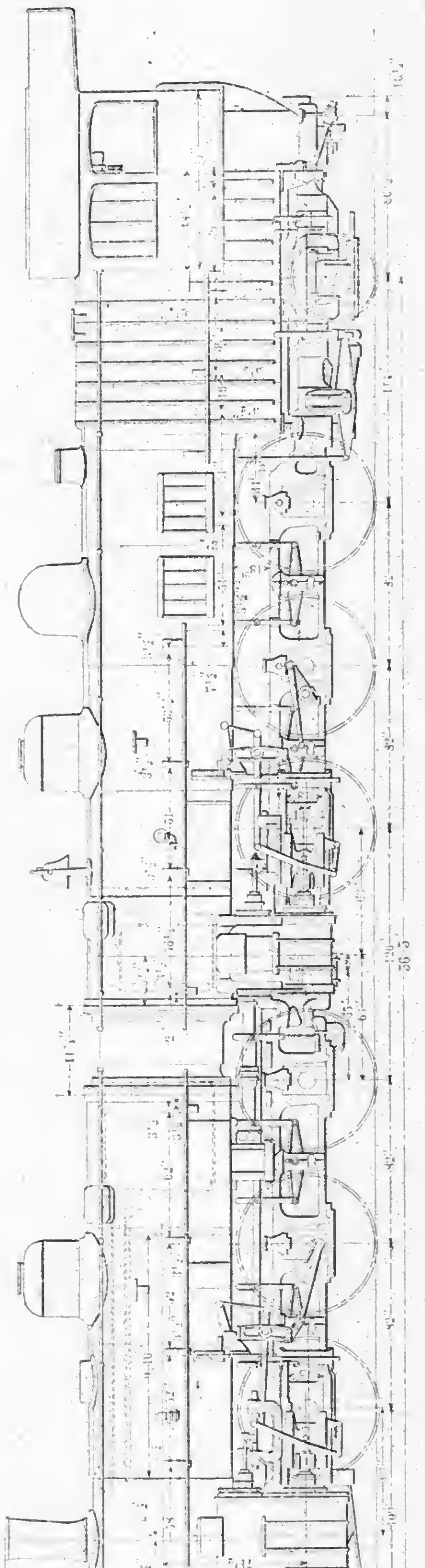

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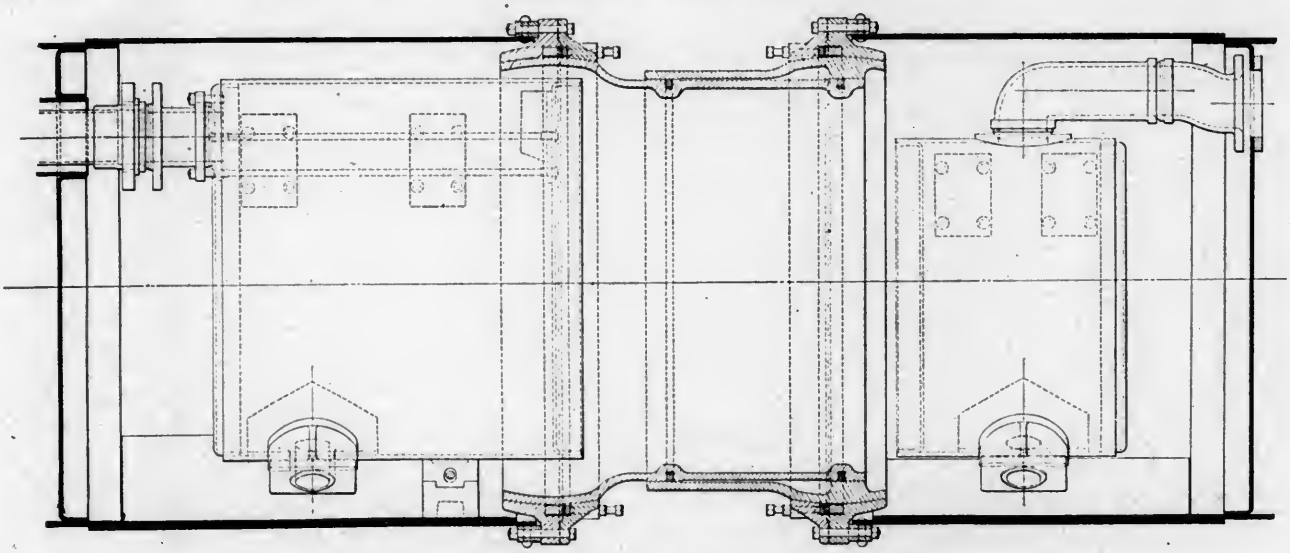
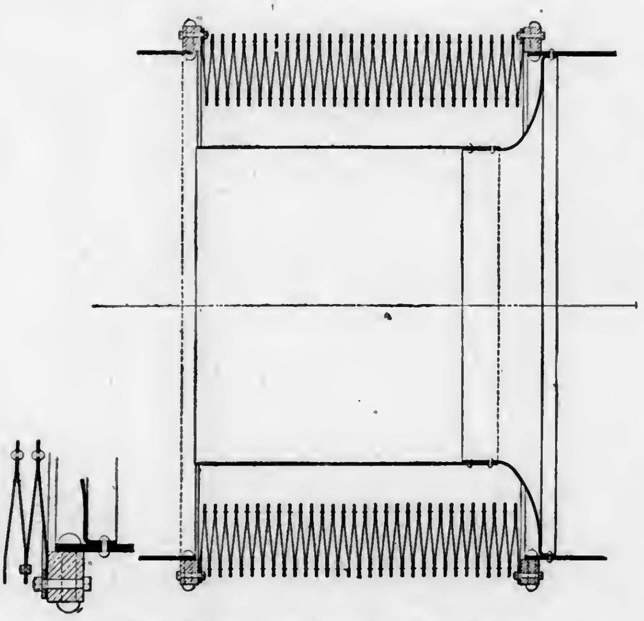
chamber just ahead of the high pressure cylinders and two arrangements are being experimented with. Since this joint is located somewhat ahead of the articulated connection between the frames, it is subjected to a combination turning and sliding motion, and therefore consists of a double ball joint and a slip joint on one locomotive and a bellows arrangement of flexible steel rings which permit universal motion in the other example. In the latter case the joint is composed of 60 rings of high carbon steel, having a thickness of No. 14 wire gauge, each ring being 10 in. wide and having an outside diameter of 71½ in. They are made with a set so that when joined together they remain a series of V shaped joints. The adjacent rings are riveted together on the inside and bolted on the outside. Inside of the joint there is a cylindrical drum 44 in. in diameter, which is riveted to the rear boiler section and extends beyond the joint, so as to prevent the lodgement of cinders in the crevices between the rings.



DETAIL OF BALL JOINT IN ARTICULATED BOILER.

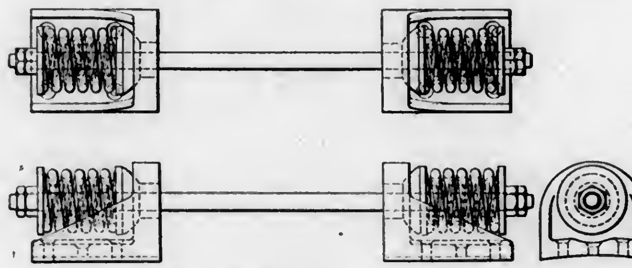


ARRANGEMENT OF BELLOWS CONNECTIONS.

On these locomotives the superheater and reheater are separate both from each other and the boiler shell, being of practically the same arrangement as has been in service on this road on the Mallet passenger locomotives mentioned above. The superheater is in the rear section and the reheater in the forward section, which makes it necessary to have flexible joints on the exhaust pipes from the high pressure cylinders only.

The front boiler section is made somewhat longer and is secured to a low pressure saddle, that is mounted on top of the steel casting containing the steam passages which is arranged about the same as in the rigid boiler engines. The rear of this section of the boiler is supported on the waist bearer and is allowed a limited amount of longitudinal movement on the frames for expansion. To assist in holding the boiler sections in alignment a centering device has been placed on each side at the horizontal center of the boiler, the construction of which is clearly shown in the illustration.

On these boilers the dry pipe is internal and the connections between the superheaters and high pressure cylinders are also made inside the boiler shell. The exhaust from the high pressure is carried through a pair of horizontal pipes fitted with ball and slip joints which terminate in the cast steel waist bearer that spans the front frames and supports the rear ends of this section of the boiler. From the reheater the steam is carried forward by a large single pipe inclosed in the flue located at the top of the feed water heater and is carried down to the connection in the low pressure cylinder casting by a single pipe.



CENTERING DEVICE ON ARTICULATED BOILERS.

It will be noted that because of the elimination of flexible connections to and from the low pressure cylinders, that the number of ball and slip joints in this locomotive is less than those with the rigid boiler. As opposed to this, however, it is necessary to have flexible connections in the injector pipe and in the feed water connection between the heater and the rear section of the boiler. These are made of sections of metallic hose of the proper size.

In the boilers built at the company's shop they use on the combination of the two old locomotives a ball joint, which is placed directly above the frame joint, which in turn is equidistance between the two adjacent driving axles. This simplifies the ball joint to a considerable extent, making it necessary to have but a single spherical section in addition to the slip joint.

The general dimensions, weights and ratios of the locomotives with the articulated boilers are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Maximum tractive effort	61,500 lbs.
Weight in working order	392,300 lbs.
Weight on drivers	317,300 lbs.
Weight on leading truck	29,000 lbs.
Weight on trailing truck	46,000 lbs.
Weight of engine and tender in working order	562,000 lbs.
Wheel base, driving	37 ft. 10 in.
Wheel base, total	56 ft. 5 in.
Wheel base, engine and tender	89 ft. 3 in.
RATIOS.	
Weight on drivers ÷ max. tractive effort	5.16
Total weight ÷ max. tractive effort	6.39
Max. tractive effort × diam. drivers ÷ evaporating heating surface	1175.00
Totalevaporating heating surface ÷ grate area	69.00
Firebox heating surface ÷ total heating surface per cent	6.48
Weight on drivers ÷ total evaporating heating surface	88.00
Total weight ÷ total evaporaitng heating surface	108.20
Volume equivalent simple cylinders, cu. ft	20.60
Total evaporating heating surface ÷ vol. cylinders	175.00
Grate area ÷ vol. cylinders	2.54
CYLINDERS.	
Kind	Compound
Diameter	24 and 38 in.
Stroke	28 in.
VALVES.	
Kind	Piston
Diameter	13 in.
Lead, constant	¼ in.
WHEELS.	
Driving, diameter over tires	69 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10x12 in.
Driving journals, others, diameter and length	9x12 in.
Engine truck wheels, diameter	31¼ in.
Engine truck, journals	6½x12 in.
Trailing truck wheels, diameter	40 in.
Trailing truck, journals	8x14 in.
BOILER.	
Style	Straight
Working pressure	220 lbs.
Outside diameter of first ring	70 in.
Firebox, length and width	119⅝x63¼ in.
Firebox plates, thickness	Sides & crown, 5-16 in.; back, ⅜ in.; tube, 9-16 in.
Tubes, number and outside diameter	294—2¼ in.
Firebox, water space	F. & B., 5 in.; S., 5½ in.
Tubes, length	19 ft. 7 in.
Heating surface, tubes	3,376 sq. ft.
Heating surface, firebox	234 sq. ft.
Heating surface, total evaporaitng	3,510 sq. ft.
Superheater heating surface	390 sq. ft.
Feed water heater tubes—No. & dia	322—2¼ in.
Feed water heater tubes, length	9 ft. 10 in.
Feed water heater, heating surface	1,893 sq. ft.
Reheater, heating surface	719 sq. ft.
Grate area	52.5 sq. ft.
Smokestack, height above rail	186 in.
Center of boiler above rail	107 in.
TENDER.	
Tank	Waterbottom
Frame	12 in. channels
Wheels, diameter	34¼ in.
Journals, diameter and length	5½x10 in.
Water capacity	9,000 gals.
Coal capacity	12 tons

FOURTH ANNUAL APPRENTICE INSTRUCTORS' CONFERENCE

NEW YORK CENTRAL LINES.

The fourth annual conference of the apprentice instructors of the New York Central Lines was held at the Grand Central Terminal, New York, on January 27, 1911. All of the apprentice instructors, numbering 22, from the ten shops on the system where schools are maintained, were present. C. W. Cross, supervisor of apprentices, assisted by Henry Gardner, assistant supervisor, had charge of the meeting. A number of general officers from the system were present, among them being the following: J. F. Deems, general superintendent of motive power; F. E. McCormick, division superintendent; F. W. Brazier, superintendent of rolling stock, and E. B. Katte, chief engineer of electric traction. Among the guests were G. M. Basford, assistant to the president of the American Locomotive Company; W. L. Davis, apprentice instructor of the Santa Fe, and W. B. Russell, director of the Franklin Union, Boston, Mass.

The meeting was opened with an address by G. M. Basford, who spoke on the subject of "The New Apprenticeship." Mr. Basford briefly outlined the conditions which surrounded an apprentice boy of 20 years ago and stated that it is not surprising that kind of an apprenticeship was a failure. He pointed out the wonderful differences of the present systems, as illustrated by the New York Central Schools, and stated that he did not believe that if the work is continued along its present lines, it can possibly fail to accomplish the results desired. He pointed out to the instructors present the peculiar advantages which they have and also the peculiar responsibility resting upon them. They labor under an almost ideal condition, as concerns the pupil and teacher, and have much more control over and influence on the whole future of their pupils than do any other class of teachers.

Speaking along these lines, Mr. Basford closed his address with the following paragraphs:

You are dealing with boys in the most impressionable age of their lives. They are at the age when the influences of home, of the church and of the public schools are likely to be weak or altogether wanting. The boys are perhaps away from home, but if at home they are drifting rapidly toward manhood and are forming the habits of their lives as to thought as well as in the occupation of their hands. They are about to establish their ideals and select companions whose influence is likely to last throughout their lives. In short, they are embryo citizens beginning to realize the independence which comes from earning their own living. At this stage you are thrown in contact with them more closely than is any other human influence. You may impress them with your own personality, your own ideas, outlook and hopes, you may bring before them standards which they will adopt. You may not do any of these things. Your influence depends very largely on your own personality, your knowledge of boys and boyhood and your ability to acquire close proximity to their lives. Perhaps you may not realize the importance of this contact, but it seems reasonable to expect that if you can get upon such close footing with them that they will trust you with their troubles, ask your advice and take you into their confidence, you will be able to mold their future to a very large extent. Do you appreciate your responsibilities in this direction?

Nothing is to be feared from the influence of any man skilled with his hands and developed in his mind for independent thought and action, but much is to be feared from a large class of workmen skilled or unskilled who allow others to think for them and who are morally weak in that they will not act with the courage of their own convictions. It seems to me that the greatest problem before the instructors of apprentices to-day lies in that part of the work which has to do with conscience and citizenship, and that in this direction lies the greatest opportunity for apprenticeship development. In this lies your greatest responsibility. If you do not realize it you fail to accomplish the greatest of all the objects lying before you.

A great deal may be accomplished through apprentice organizations, debating clubs, athletic teams and other influences which tend to develop individual initiative in connection with the team work idea. Boys need to manage something to develop self-government in order to realize that the world has a right to expect them to take their places in the human organization of life in general and in order that they may become self-reliant units in that organization.

Summing up I would like to lay before you three facts: You are working under ideal conditions as to the relationship between instructor and pupil. This relationship renders it possible for you to exert most powerful influences over the character and the future of your students. The most vital object of this whole movement is to produce men, American workmen, skilled, resourceful, honorable men, men prepared and inclined to fulfill their obligations.

F. H. Colvin, managing editor *American Machinist*, spoke briefly on the subject of "The Conservation of Workmen," drawing attention to the fact that nearly all the States are paying considerable attention to the problem of compensation for injured workmen. He pointed out how the apprentice instructors could do very much to reduce the possibility of injury through proper training of apprentices and in this way help reduce the economic loss, both to the individual and the community, that is always present in the case of a serious injury to a workman.

J. F. Deems complimented the instructors present most highly on what they have done and what they are now doing. Mr. Brazier and Mr. Katte also spoke briefly to the same point.

In opening the conference Mr. Cross spoke in part as follows:

It is gratifying to know that there are now at least twelve railways in the United States where a systematic course of apprentice instruction is being pursued with marked success. Skilled instructors are leading the young mechanics through graduated courses to a thorough knowledge of their calling and the results are so far most encouraging. The important element of natural selection is markedly active in many of the shops. Under proper instructions it is speeedily recognized whether the young man has made the proper choice of a calling or not. The unfitted are weeded out and directed to other fields. The moral and intellectual tone of the student apprentice is elevated. Life becomes sweeter and higher and nobler when the difficulties of a calling are illumined by intelligent and kindly instruction. The burden of labor lies lightly on the shoulders of the studious youth who can call the gathered wisdom of a proficient instructor to his aid. To this is added another important factor—that the amount of work or output of the apprentice shows a marked increase where there is an instructor. Hence the apprentices under the new system are being better paid, with the result that instead of being a burden on their parents or guardians during their apprenticeship, the young mechanics are self-

supporting from the beginning, and when they graduate they have the proud consciousness of knowing that they are fitted to take part in the world's work without fear or favor.

On March 1, 1906, the apprenticeship department was created and a few weeks later the work was well started at nine of the shops. We have completed the cycle of the work and the graduates now turned out have had the full four years course of training. The courses of study have been revised and improved and specialized to fit the several trades in a manner that has met with the approval of all interested persons. The graduates are used to good advantage in the service, and as a proof of the efficiency of the training system, when graduates are re-employed as mechanics at the completion of the apprenticeship they are given a generous rating, and in many cases the maximum rate in the trade in which they are re-employed."

The annual statistical report presented by Mr. Gardner showed that on July 1, 1910, there were 617 apprentices enrolled, an increase of 62 over the previous year. Fewer apprentices had been discharged than any previous year, showing closer attention to the weeding out of undesirable material during the six months probationary period.

The question of the possibility of getting the standard for apprentices too high was brought up for discussion. It seemed to be the consensus of opinion of the speakers that high school graduates made the best class of apprentices. Mr. Rauch, drawing instructor at Oswego, stated at the conference three years ago that he preferred apprentices from the seventh or eighth grade of public schools to those who had had a high school education. He now stated in this discussion that he had been compelled to change his mind and was willing to take all the high school boys he could get.

On the subject of giving prizes for particularly good work, it seemed to be the consensus of the meeting that it would be unwise to institute this policy.

The importance of allowing an apprentice to develop initiative and self-confidence as far as possible was brought out in the discussion of the subject, "Results of Modern Apprenticeship," which was opened by F. Deyot, Sr., of East Buffalo.

A course for electrical apprentices was outlined by C. A. Towsley, of Elkhart, which aroused considerable discussion. Mr. Russell stated that the results in Boston seem to demonstrate that successful instruction in this field requires the use of electrical apparatus in a laboratory and suggested the advisability of equipping an instruction car with such apparatus for the use of all the shops on the system.

In connection with the discussion on the subject of monthly reports for the parents, it was the opinion of the meeting that some kind of a simple report, which could be sent to the parents each month indicating the standing of the apprentice in his school and shop work, would be productive of good results.

Other subjects which were introduced and discussed, included the following: "Laboratory Work," "Walschaert Valve Gear," "The Backward Boy," "Loyal and Satisfied Apprentices," "Results" and "Car Builder Apprentices."

A paper prepared by one of the apprentices at Oswego, showing the value of the apprenticeship instruction as seen from the standpoint of an apprentice himself, was read at the meeting. Part of this paper is given below:

Every mechanic expects the apprentice to "hop" to his music; every apprentice knows the mechanic will "kick" to his tune, for the mechanic has no time for the "greeny." The only man who understands apprentice language is the "angel," which is slang for shop instructor, but it is no miss to call him such, for without him the greeny would never grow, but would be at a standstill half his time. Sometimes we wish the angel was twins, even triplets would no morer than meet the demand. * * * *

The rate paid a first year apprentice is out of propotrion to his needs; even a first yearer must eat like a man and dress as a man in order to work like a man; he looks like a man and feels like a man until he puts his hand in his pocket. The apprentice who clothes himself, buys tools, carries some protection, pays apprentice club dues, church and shop collections, is obliged to pay his nearest relatives for board, washing and mending in "promisosry notes" (no time of payment specified), must be blind on the girl side of the road and put the curb on a growing sociability. All this hurts; it might be called, "apprentice cramp"; it squeezes the region of the short rib and produces imperfect vision. A dime looks the size of a car wheel and it makes as many revolutions in his pocket as one going a mile a minute before it disappears into spend-land. I might go further and say it leads to defective hearing, for the jingle of small coin is so sweet to the ear that many a fellow adds keys, nails and tool checks to swell the sound so that in time he becomes stone deaf to the ring of real money. Apprentice cramp is a disease that carries off many of the first yearers and deters many other desirable fellows from becoming apprentices. Another trouble is the discovery that physically he is not adapted to the trade he has started, yet rather than start another at first year rate he drops out. This is a loss to the railway as well as to the boy and it's up to them to remedy it. The high school boy of to-day is more inclined to mechanics than ever before if the rate paid was more proportional to his wants.

The classroom is the smoothing iron that rubs out all the wrinkles of discontent, for the apprentice looks forward to these hours with pleasure. "Up to the college," has almost the ring of "come on to the ball game," and the class instructor is regarded as a 'dad' by all the boys. Even the fellow who went in with a sneer goes out with a thank you. Next to the school is the club; here the apprentice spreads his wings for his first flight in oratory, here he gets used to hearing his own voice and gets over the scare of the sound of it, here he also sharpens up his wits for defense or his tongue for attack and here he talks railway, reads railway, and grows to be a railroader.

FEDERAL LOCOMOTIVE BOILER INSPECTION BILL

The substance of the bill which, after nearly a year of discussion, hearings and investigation of the subject, passed the Senate on January 10, and the House on February 7 is given below:

Section 1. Applies to all interstate railways.

Section 2. From July 1, 1911, it shall be unlawful to use any steam locomotive in moving interstate traffic unless the boiler and appurtenances are in proper and safe condition to move traffic without unnecessary peril to life or limb; and all boilers shall be inspected [by the roads], in accordance with rules to be prescribed, and be able to withstand tests provided by such rules.

Section 3. The President, by and with the advice and consent of the Senate, is to appoint a chief inspector of locomotive boilers (salary $4,000) and two assistant chief inspectors (salary $3,000 each).

Section 4. The chief inspector is to divide the country into 50 districts, and an inspector is to be appointed for each district; salary $1,800, with $600 for office rent, stationery and clerical assistance. These 50 inspectors are to be appointed by the Interstate Commerce Commission after competitive examinations, according to the rules of the Civil Service Commission. The chief inspector is to prepare a list of questions, which, when approved by the Interstate Commerce Commission, is to be used by the Civil Service Commission as a part of its examination.

Section 5. Each carrier shall file its boiler inspection rules, which, after hearing and approval by the commission, shall become obligatory on such carrier. If the rules are not duly filed, the chief inspector shall prepare rules for that carrier. A carrier may change its rules from time to time, on approval by the Interstate Commerce Commission. The general rules for the inspectors are to be prepared by the chief inspector and approved by the commission.

Section 6. Each inspector is to become familiar, so far as practicable, with the boilers in his district; and make personal inspections from time to time as may be necessary to carry out the law and as may be consistent with his other duties. His first duty shall be to see that the carriers obey the law and repair defects promptly. Each carrier must send to the inspector duplicate sworn reports of each inspection and also of what has been done to repair defects found by inspection. An inspector finding a boiler out of order is to notify the carrier in writing and thereafter the boiler must not be used until repaired. Within five days the carrier may appeal to the chief inspector for re-examination and another man must then re-examine, within 15 days; if still dissatisfied, the carrier may within 30 days appeal to the commission, which may overrule the inspector or the chief inspector. Pending either appeal, the inspector's first decision shall stand.

Section 7. The chief inspector shall make an annual report to the commission.

Section 8. Boiler accidents resulting in serious injury or death must be forthwith reported in writing and the chief inspector shall investigate or order investigation. Parts of damaged boilers must be kept so that they can be seen by the inspectors. The commission may at any time call on the chief inspector for a report of any accident and may publish the same with recommendations. Such reports must not be used as evidence in suits for damages.

Section 9. Penalty for violation $100.

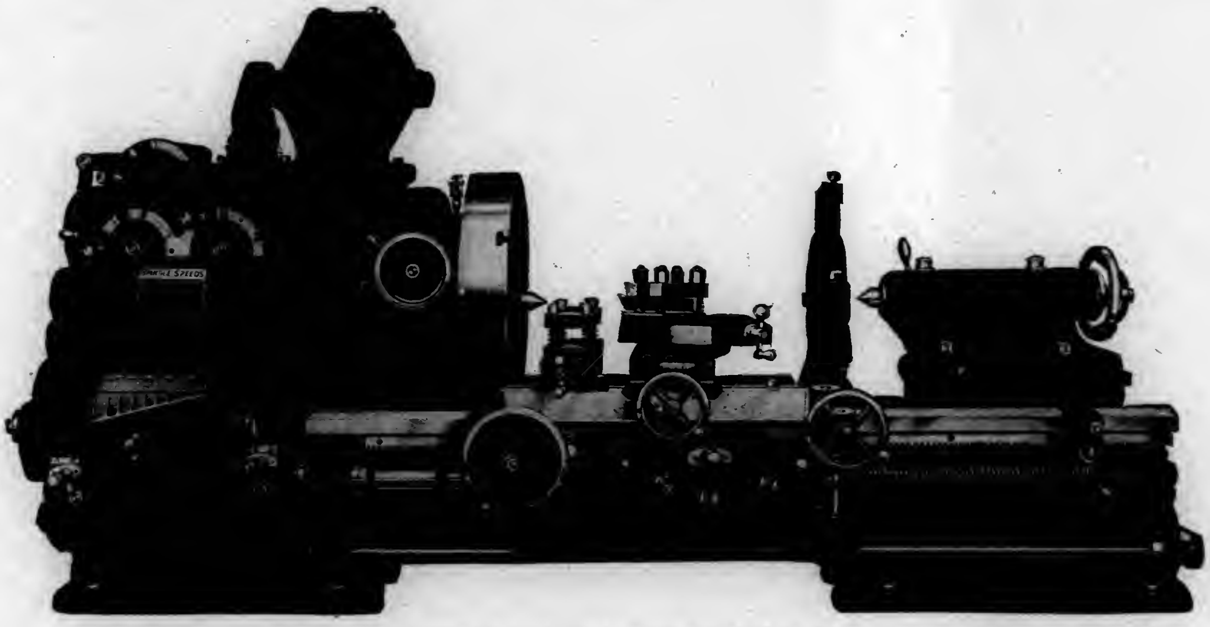
DEVELOPMENT OF THE HIGH DUTY LATHE

The powerful machine shown in the illustration, designed and built by the American Tool Works Co. of Cincinnati, O., represents the latest developments in high duty lathes, and in power, range of work and convenience is an advance over similar sizes of previous design. Some idea of the enormous power of these lathes may be gained from the fact that for motor drive the builders recommend a 20 h.p. motor, and guarantee the machine to work without strain under continuous service of 50 per cent. overload of the motor. Although these lathes are strictly new in design they are by no means still in the experimental stage, as the builders have installed several lots, and in every case they have exceeded expectations.

An analysis of these machines is replete with interest. The severe duty required of a lathe of this size has been given most careful study and every vital point is fully developed. The exceptional solidity of the machine deserves particular mention, as an abundance of metal is used just where it is needed to insure the utmost rigidity, thereby overcoming practically all chatter and vibration, and resulting in true, smooth work. A minimum of power is wasted throughout the drive because of the reduction in the number of running parts, together with the most direct form of drive to the main spindle and through the feed gears. This, coupled with excellent lubrication, insures the highest percentage of power delivered to the tool. Steel gears, which are liberally distributed throughout the machine where experience has shown them to be necessary, are of the coarsest pitch practicable, and cut from the solid with special cutters, no range cutters being used.

The lathe bed is of deep section, exceptionally heavy, and thoroughly braced by cross box girths at short intervals its entire length, a construction which affords a degree of rigidity sufficient to resist the heaviest cuts without vibration. This is the American Tool Works Co.'s patented drop "V" pattern, which gives great additional swing, and permits of deepening the carriage bridge more than is possible with the "standard" form of bed. The bed is further strengthened by a web cast through the center, which carries a rack for engaging the pawl dropped from the tailstock. The "Vs" are large and accurately scraped, and the wall at the tailstock end is cut out to permit of slipping the tailstock off without taking out the bolts. The gear box and lead screw bearing are seated with tongued and groove fit, thereby securing accurate and permanent alignment. The steel feed rack is of best quality, with teeth cut from a solid bar.

A constant speed motor either of the direct or alternating current type is located on top of the patented geared head, which is the triple geared type, and is connected to the main driving shaft through spur gearing. Sixteen spindle speeds are obtainable through a medium of positive clutches and slip gears, the clutches being of the selective type easily engaged, while the teeth of the slip gears are machine rounded, thus causing them to slide easily into mesh, on the same principle as many automobile transmission gears. The gears are all mounted on long bronze sleeves which are oiled by means of eight feed oilers from the outside of the head. A distinctive feature in this new design is the fact that of the 16 speeds provided, 8 are obtained directly through the spindle gear and the other 8 through the face plate drive. It will be recalled in this connection that in the usual type of triple geared lathes only one-third of the speeds are obtained through the face plate drive. This arrangement necessitates using the spindle gear drive for a great deal of heavy turning on large diameter work. In the case of the new machine under consideration this is handled through the face plate drive, thus relieving the spindle of the enormous strain.



NEW AMERICAN HIGH DUTY LATHE WITH MOTOR DRIVE.

The fundamental speed changes are made through the manipulation of the levers on front of the headstock. The motor speeds can be comparatively high, 700 to 1,000 r.p.m., thereby keeping down the size as well as the first cost. All of the speed changes can be made without stopping the central drive, as the machine may be started and slowed by means of a friction clutch which engages and disengages a driving pulley or motor gear from the shaft. This clutch is operated by lever with a very sensitive control, thus enabling the operator to quickly make the various speed changes. The positions of the lever for the various spindle speeds are plainly indicated on the index plate on the front of the head. This plate has been very carefully worked out and every lathe operator will appreciate its simplicity and the ease with which each spindle speed is obtained.

One of the most notable features of these new lathes is the rapid change gear mechanism. All gears at this point are of steel, the material used being of the very best obtainable, either of bar steel or drop forgings. The mechanism is embodied in a self-contained unit carried on the front of the bed and provides 32 fundamental changes of threads ranging from one to 14 per inch. In addition to this a compound quadrant gear is provided on the end of the bed which will furnish 16 additional changes, thus affording 48 thread and feed changes, ranging from one-half to 28 threads, including 14½ pipe thread, and from 4 to 244 cuts per inch. The 32 changes in the box are

all obtained through the medium of a cone and tumbler gear and two sliding clutches of the selective type. Anyone of these changes may be instantly obtained while the machine is running. The quadrant mentioned also provides means for obtaining through loose gears any odd rates or feeds which may from time to time be desired. The cone gears are all of the Brown & Sharpe 20° involute pointed design which provides an exceptionally strong type and greatly facilitates the engaging of the gears while running.

One great feature of this quick change mechanism which is distinctively superior and cannot be found in other designs, is that which eliminates the necessity of speeding up at any time for any of the different feeds or threads. The coarse threads and feeds are all obtained through the cone, and no member in the box at any time runs faster than the initial driving gear. The value of this construction must appeal to those interested in and familiar with lathes. The index plate completely worked out is in full view of the operator on the front of the gear box, and shows the exact setting for each thread or feed.

The detail construction of the head is of much interest, and in that connection the point is very important that all driving is done either through short shafts or through sleeves, there being no long shafts in torsion at any time, thus eliminating all possibility of binding or chatter. All gears in the driving mechanism are of unusually coarse pitch, and the pinions are made of steel cut from the bar. Another very important point in connection with the head construction is the elimination of all loose gears from the spindle. The spindle is of high carbon, hammered steel, accurately ground, and has a hole 2⅝ in. its entire length. The bearings are of the best quality phosphor bronze, and equipped with sight feed oilers. It is of taper form, a construction common to wheel lathes. The only gear on the same spindle with the driving gear is set close against the front spindle bearing. The spindle is therefore at no time under severe torsional strain. This feature adds greatly to the life of the bearings and the alignment of the spindle.

There are other features worthy of mention such as the ability to draw the rack pinion from the feed rack when cutting threads, the impossibility of simultaneously engaging the feeding and screw cutting mechanism, the fact that all gears and pinions in the apron are of steel, cut from the solid with special cutters; hardened and ground studs and shafts, and the extra heavy carriage which is 13 in. wide and unusually deep. Since a lathe of this size requires easy access to crane service and is frequently operated overtime, it is considered the best practice to provide for individual motor drive. The lathe is then a complete unit and can be operated at any time without running the central power plant. It also overcomes the difficulty of drive experienced when the machine is to be located far from the line shaft or in places where it is not practical or desirable to install one.

STANDARDIZATION OF CHILLED IRON CAR WHEELS*

During the year 1909 the M. C. B. Association recommended as standard three weights of chilled iron wheels, viz., the 625-lb. for cars of 60,000-lb. capacity; the 675-lb. for cars of 80,000-lb. capacity, and the 725-lb. for cars of 100,000-lb. capacity. The performance of these wheels is practically perfect when operating under conditions which can reasonably be interpreted as conforming to those of the three classes of cars. It would naturally be supposed that the equipment of all railways would be divided into three classes so that all items of service relating to the wheel should be proportionate to the 625-lb., 675-lb. and 725-lb. wheel. While this is true of 90 per cent. to 95 per cent. of the equipment, there has been a tendency of late in certain sections to increase the percentage of brake pressure to the light weight of the car, and in the case of refrigerator cars and heavy furniture cars of light capacity, the weight of the car allows a higher braking power in total than corresponds with its capacity. It is of extreme importance that the capacity of the wheel should correspond with the intensity of the braking power of the car.

It is doubtful if one wheel in a million would break in service if applied to such cars as we may reasonably infer are specified in the M. C. B. recommendations for each capacity. It is therefore important that the recommendations be closely studied and followed—they are as follows:

MASTER CAR BUILDERS' RECOMMENDED WEIGHTS OF CHILLED IRON CAR WHEELS.

Weight of wheel	625 lbs.	675 lbs.	725 lbs.
Axle capacity	22,000 lbs.	31,000 lbs.	38,000 lbs.
Gross load	88,000 lbs.	124,000 lbs.	152,000 lbs.
Deduct car capacity	60,000 lbs.	88,000 lbs.	110,000 lbs.
Weight of car	28,000 lbs.	36,000 lbs.	42,000 lbs.
Brake pressure at 70 per cent	19,600 lbs.	25,200 lbs.	29,400 lbs.

NOTE.—80,000-lb. and 100,000-lb. capacity cars calculated at 10 per cent. excess load.

SUMMARY.

	Gross Load.	Brake Pressure.
625-lb. wheel designed for	88,000 lbs.	19,600 lbs.
675-lb. wheel designed for	124,000 lbs.	25.200 lbs.
725-lb. wheel designed for	152.000 lbs.	29.400 lbs.

The brake pressure under the majority of equipment is 70 per cent. of the light load of the car, and using this as standard we may determine the brake pressure corresponding to each wheel. Heat is developed through brake friction; therefore, the brake pressure when continuously applied represents the rate at which heat is being developed, other things being equal, and therefore brake pressures should be proportional to that part of the wheel which resists the temperature stresses—the plate.

The question arises just how to determine the relation of the wheel to the brake pressure. As stated above, we assume that the conditions as laid down by the M C. B. Association are entirely satisfactory, and by considering the braking strength of the plate to vary as the square of its thickness, and its strength in tension when resisting temperature stresses to vary directly as its thickness, Table No. 1 was prepared for and published by the Association of Manufacturers of Chilled Car Wheels.

TABLE No. 1.
Thickness of Plates Required in Cast Iron Wheels to which Brakes Are Applied.

Maximum Gross Load on 8 Wheels.	Thickness of Plates Reqired in Each Wheel to Safely Carry the Load.	Total Braking Power of Car.	Thickness of Plate to Be Added to Take Care of Temperature Stresses.	Required Thickness of Tread.
Pounds.	Inches.	Pounds.	Inches.	Inches.
40,000	.36	12,500	.16	....
50,000	.41	15,000	.19	....
60,000	.45	17,500	.22	1.50
70,000	.48	20,000	.25	....
80,000	.52	22,500	.28	1.62
90,000	.55	25,000	.31	....
100,000	.58	27,500	.34	1.75
110,000	.60	30,000	.37	....
120,000	.63	32,500	.41	1.87
130,000	.65	35,000	.44	....
140,000	.68	37,500	.47	2.00
150,000	.71	40,000	.50	....
160,000	.73	42,500	.53	2.12
170,000	.75	45,000	.55	....
180,000	.77	47,500	.59	2.25
190,000	.79	50,000	.62	...
200,000	.81	52,500	.66	2.37
210,000	.84	55,000	.69	....
220,000	.86	57,500	.72	2.50
230,000	.87	60,000	.75	...
240,000	.89	62,500	.78	....
250,000	.91	65,000	.81	2.50

TABLE No. 2.
Weights of Various Diameters of Wheels with Different Thicknesses of Plates.

Weight of Wheels.

Thickness of Plates in Inches.	36 in. Diam.	33 in. Diam.	30 in. Diam.	28 in. Diam.	26 in. Diam.	24 in. Diam.
.62	640	550	480	440	390	3[illegible]0
.68	665	575	500	455	405	3[illegible]0
.75	690	600	525	470	420	375
.81	715	625	550	485	435	3[illegible]0
.87	740	650	575	500	450	4[illegible]5
.93	770	675	600	520	465	4[illegible]0
1.00	800	700	620	540	480	4[illegible]5
1.06	830	725	640	560	495	4[illegible]
1.12	860	750	660	580	510	4[illegible]
1.18	890	775	680	600	525	4[illegible]0
1.25	920	800	700	620	540	...
1.31	950	825	720	640	...	...
1.37	980	850	740	660	...	...
1.43	1010	875	760	...	...	...
1.50	1040	900	...	...	...	...

Table No. 1 divides the required thickness of the plate required in a wheel for ordinary railway service in two parts:

1.—That required to carry the load.

2.—That required to resist temperature stresses as represented by brake pressure.

* Abstracts from a paper read by W. S. Killam at the January meeting of the Western Ry. Club.

The sum of these quantities gives the required thickness of the plate in the wheel.

Table No. 2 has also been prepared for the Association of Manufacturers of Chilled Car Wheels to show the approximate weight of a wheel for all usual diameters when the thickness of plate is specified. With these two tables at hand it requires but a moment to decide whether any wheel harmonizes with the service conditions. The method of using the table is as follows:

Example.—What wheel should be used under a refrigerator car having a gross load of 90,000 lbs. and braking pressure of 37,500 lbs.? Referring to Table No. 1 we have the following:

Thickness of plate corresponding to gross load of 90,000 lbs.	.55 in.
Thickness to be added on account of 37,500-lb. brake pressure	.47 in.
Total thickness of plate	1.02 in.
Referring to Table No. 2, weight of wheel is	700 lbs.

Table No. 1 is for use only when considering cars in miscellaneous service, that is, where cars of all classes are coupled together in one train; the application of this rule is simply to produce a distribution of retarding force to each wheel in proportion to its size. When the trains are made up of the same kind of cars and operated on heavy grades, another principle applies. In this case the wheels are all alike, and the braking

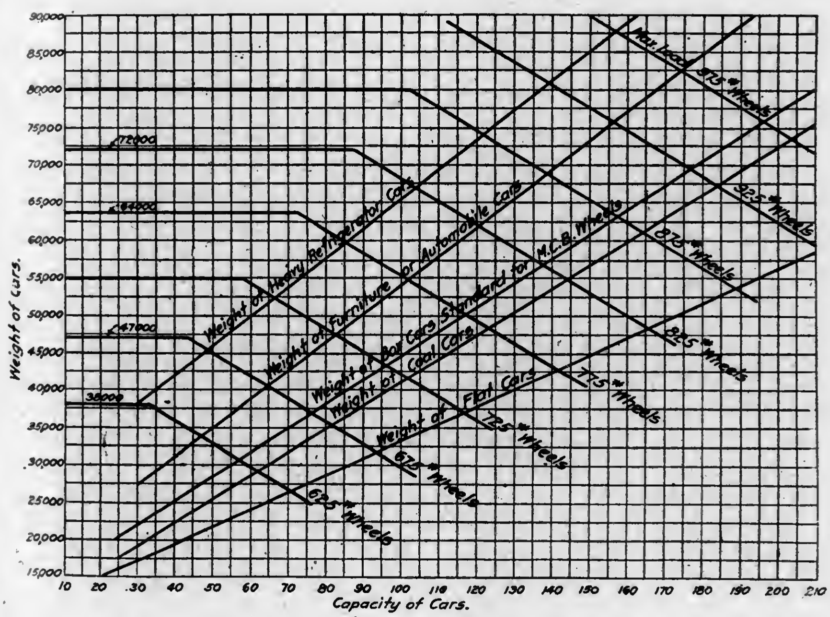


CHART TO AID IN CHOOSING WHEELS.

power uniform on all cars, hence the rate at which heat is produced is determined solely by average gross load and the rate of grade. In this case it is entirely immaterial how brake pressures are calculated, for it is self-evident that sufficient braking power for each car must be used to offset the gravity effect of the average gross load per car, and no more or no less. To take care of this situation Table No. 3 has been prepared.

This table shows how the weight of the wheel should vary with operating conditions and is intended as a guide for choosing the proper standard wheel to suit any operating condition. From the experience gained in observing the performance of trains made up of fully loaded cars of one kind and operated on 4 per cent. grades, such as often occurs in mining districts, the maximum safe operating conditions for wheels have been established and are shown in Table No. 3.

TABLE No. 2.

Effect of Gross Load and Grade on Wheel Design.

Gross Load 75 tons.	1%	2%	3%	4%
Thickness plate, in inches, to carry load	.71	.71	.71	.71
Additional thickness for grade	.15	.30	.45	.60
Total thickness	.86	1.01	1.16	1.31
Weight of wheels, lbs	646	706	766	825
Gross Load 60 tons.				
Thickness plate, in inches, to carry load	.63	.63	.63	.63
Additional thickness for grade	.12	.24	.36	.48
Total thickness	.75	.87	.99	1.11
Weight of wheels, lbs	600	650	700	750
Gross Load 50 tons.				
Thickness plate, in inches, to carry load	.58	.58	.58	.58
Additional thickness for grade	.10	.20	.30	.40
Total thickness	.68	.78	.88	.98
Weight of wheel, lbs	575	612	654	692
Gross Load 40 tons.				
Thickness plate, in inches, to carry load	.52	.52	.52	.52
Additional thickness for grade	.08	.16	.24	.32
Total thickness	.60	.68	.76	.84
Weight of wheel, lbs	550	575	604	637

Use of Tables.—These tables furnish a ready means of examining any operating condition of freight cars and freight engine tenders to determine whether the wheels are properly standardized. The tables represent the maximum safe combination of load and braking power that are safe for chilled iron wheels. The safe operating stress for the wheel is governed by the properties of metal of which the wheel is composed. Operating conditions of load, grade and brakage are fixed by the railway. The obvious responsibility of those having charge of standardization of wheels is to harmonize the wheel to the maximum conditions under which it must operate. Tables No. 1 and No. 3 are to be used exactly as tables for the strength of I-beams, channels, angles, etc.

Graphic Chart.—As a further aid in choosing wheels for various conditions, a chart has been prepared which extends beyond the limit of present freight cars. The object of this chart is to show in what classes of equipment brake pressures are likely to be in excess of safe wheel practice. Fortunately the cars at present under which the wheels are not properly standardized are comparatively few, and the remedy is easily applied.

The vast majority of wheels are properly standardized and the improper standards exist in a very small percentage of cars. This is all the more reason why these errors should be corrected. The total percentage of refrigerator cars is only 1.36 per cent., and there is probably about the same percentage of furniture cars. There are several ways in which corrections can be made. The recent tendency is to obliterate the different classes of cars by building a few cars of the smallest capacity, having largest brake pressure, thus placing these cars, as far as the wheel requirements are concerned, in the heavy class, and a wheel should be made to take care of all such non-standard cars.

This wheel would be the 625-lb. wheel with 75 lbs. added to the plates; in other words, what is needed is a heavy wheel with small center core size. The result of such a standard would be the practical elimination of wheel troubles in the important class of cars handling perishable freight where it is important that delays should not occur. If it should be impractical to have a standard wheel for refrigerator and heavy furniture cars, then the alternative is to have but one wheel for all classes of cars. This would be far more expensive, as it would be necessary to increase the weights on 95 per cent. of the 60,000-lb. class of cars because 5 per cent. of this class require heavy wheels. It is not practical to use the present standard 675-lb. wheel for refrigerator cars, for in the first place making the core size smaller would add at least ten pounds to the hub and the weight would then be 685 lbs. It becomes necessary, if the 675-lb. standard is maintained, to take ten pounds of metal from the plates. The tread of the 675-lb. wheel is much heavier than required for the gross load carried by refrigerator cars, hence the final result would be but a slight improvement over the 625-lb. wheel.

Another solution is to abandon the present 675-lb. wheel and use the 725-lb. under both 80,000 and 100,000-lb. cars, because in many cases there is no difference to speak of in these two classes, and better service would be secured in the 80,000-lb. class. The standards would be:

725-lb. wheel for 80,000-lb. and 100,000-lb. capacity cars.

700-lb. for refrigerator, furniture, and other heavy cars of the 60,000-lb. capacity class, and also for 70,000-lb. capacity cars.

625-lb. for ordinary 60,000-lb. and less capacity cars, and the lighter refrigerator cars.

This would be the best solution, as it would take care of all cars of the 80,000-lb. class which have a braking power in excess of that of the average 80,000-lb. class, such as refrigerator cars, furniture cars, etc. The 725-lb. wheel is correct for most 100,000-lb. capacity service. There are a few cases, however, of dairy products cars and special cars of very heavy weight which would require special consideration.

It is the custom with most railways to purchase the three weights of M. C. B. wheels and use them indiscriminately in freight, engint and passenger service, the only item considered being the weight of the wheel and size of journal. Fairly good results have followed from this practice on roads where brakes are seldom applied to prevent too high an acceleration of speed on descending grades, but on heavy grades where the conditions imposed on the wheel are greater than those ordinarily encountered in freight service for the same weight of wheel, special consideration is required. This subject has been given careful consideration during the last two or three years and designs have been developed which answer every service requirement.

In making up the designs for wheels in service under engine tenders the same relation to service conditions are followed as shown in Table No. 1, which is based upon the M. C. B. recommendations for freight service. The difference between engine tender service for a given gross load and freight service for an equal load is that the weight of the tender when empty is much greater than that of a freight car; because the tender is always partially loaded, the braking power is made at a higher percentage than is common in freight service, so that the temperature stresses in tender wheels are very much greater than in any of the cars in the same train; for example:

Let us assume a tender having a capacity of 8,000 gal., using an axle with 5½ in. x 10 in. journals. The items relating to the wheel problem are as follows:

Weight loaded	150,000 lbs.
Weight empty	56,000 lbs.
Brake pressure at 90 per cent	50,400 lbs.

It will be noted that as far as the load is concerned an axle of the same dimensions used under 100,000-lb. capacity cars is sufficient and it is assumed by a good many roads that, therefore, the 725-lb. M. C. B. wheel is equaly as satisfactory as in freight service. This conclusion may be approximately true on roads where there are no grades of sufficient consequence to call for continuous operation of brakes, but on roads having steep grades requiring brake action to control the speed of the train it can readily be seen that the condition is very different from that of wheels under freight cars.

It was shown that the 725-lb. wheel is designed for cars having approximately 30,000-lb. brake pressure. The problem resolves itself to the following:

Engine tender, braking power	50,000 lbs.
725-lb. wheel designed for braking power	30,000 lbs.
Excess braking power	20,000 lbs.
From Table No. 2, 725-lb. wheel has plate thickness	1.06 lbs.
From Table No. 1, excess metal required for 20,000-lb. braking power	.25 in.
Thickness of plate required for tender wheel	1.31 in.
From Table No. 2 weight of 33-in. wheel, plate thickness 1.31 in.	825 lbs.

This shows that to obtain the same factor of safety under an engine tender having a gross load of 150,000 lbs., as in freight service, that an 825-lb. wheel is required. Wheels of this character will produce the best results.

Another reason why wheels for tender service require a larger section of metal in the plate is that many engines are equipped with straight air brakes which are used independently on the engine. Therefore it is possible to use the brakes on the tender wheels with greater frequency, or with greater intensity, than on the entire train. Also on account of the short wheel base and the high center of gravity of the load, there is more swaying and greater shifting of the load from one wheel to another than in ordinary service. This coupled with the desire to give a higher factor of safety in engine service demands a wheel in which all parts are proportioned to the stresses which are known to apply to the wheel.

Table No. 5 shows in general the weights of wheels which should be used in engine tender and engine truck service.

TABLE No. 5.
Weight of Engine Tender Wheels.

Capacity, Gals.	Weight of Tank.	Total Load.	Thickness of Plates in Inches.	Weight of Wheels.	Size of Journal.
3,000	21,000	60,000	.68	600	3¾ x 7
4,000	28,000	80,000	.75	600	4¼ x 8
5,000	35,000	100,000	.87	650	4¼ x 8
6,000	42,000	120,000	1.00	700	5 x 9
7,000	49,000	140,000	1.12	750	5 x 9
8,000	56,000	160,000	1.25	800	5½ x 10
9,000	63,000	180,000	1.37	830	5½ x 10
10,000	70,000	200,000	1.50	860	6½ x 12

Weight of Engine Truck Wheels.

Diameter.	For Less Than 6,000 Pounds Pressure.	For 6,000 to 12,000 Pounds Pressure.	For 12,000 to 16,000 Pounds Pressure.
24 ins.	410 lbs.	450 lbs.	480 lbs.
26 "	460 "	500 "	535 "
28 "	510 "	560 "	600 "
30 "	675 "	635 "	680 "
33 "	650 "	735 "	800 "

A great many passenger cars are equipped with chilled iron wheels and no failure has been reported in years in regular passenger service.

TABLE No. 6.
Weight of Passenger Car Wheels.

Capacity.	Weight of Car.	Total Load.	Thickness of Plates in Inches.	Weight of Wheels.	Size of Journal.
8 Whl. Trk.	20,000	35,000	.68	600	3¾ x 7
8 " "	30,000	45,000	.68	600	3¾ x 7
8 " "	40,000	55,000	.81	625	3¾ x 7
8 " "	50,000	65,000	.93	675	3¾ x 7
8 " "	60,000	80,000	1.06	725	3¾ x 7
8 " "	70,000	90,000	1.18	775	3¾ x 7
8 " "	80,000	100,000	1.31	815	4¼ x 8
12 " "	80,000	100,000	1.00	700	4¼ x 8
8 " "	90,000	110,000	1.43	845	4¼ x 8
12 " "	90,000	110,000	1.06	725	4¼ x 8
8 " "	100,000	120,000	1.56	875	5 x 9
12 " "	100,000	120,000	1.12	750	4¼ x 8
12 " "	120,000	140,000	1.31	815	4¼ x 8
12 " "	140,000	160,000	1.43	845	4¼ x 8

The weight of wheels for passenger service is shown in Table No. 6. This is based largely on Table No. 1, although it is self-evident that the factors for passenger service are different than those for freight service in that the tonnage to be controlled by the brakes is less, and therefore, for continuous application of the brakes less braking power is required. However, as passenger trains require special factors of safety, the wheels should not be lighter than shown in Table No. 3 for 4 per cent. grades. Chilled iron wheels were used under the first Pulman coaches, but as the coaches grew heavier the service became too severe for the then existing designs of chilled iron wheels, viz., 650 lbs. for 36-in. wheels, and inasmuch as there was no heavier design for the chilled iron wheel at that time, a change was made to the heavy steel-tired type of wheel. The service on passenger cars is not nearly so severe as in heavy freight and engine service, and therefore the chilled iron wheel, if of proper weight, is eminently adapted to this traffic as indicated by the large number of cars equipped with them in constant service year after year with no wheel failures.

It is almost self-evident that wheels should not be purchased as freight wheels and used indiscriminately in engine and passenger service, for the reason that the operating stresses in the wheel are not the same in both cases. The process of selection is thoroughly recognized in all materials entering into the construction of passenger equipment and should be extended to the wheels, which are the most important part of the structure.

Large sums of money are spent to procure safety in other directions, while practically nothing is allowed the chilled iron wheel maker for producing the best that can be made for this service. Where it is known that wheels are ordered for passenger and engine service, special selection can be made in the foundry of the taps from which they are poured, special treatment in annealing and special tests after the manufacture has been completed can be applied

The same rules apply here as in the manufacture of any other article. There is an opportunity for selecting from the mill run of any product in order to secure the most select for any special service. Also during the last two years considerable progress

has been made in the use of alloys which can be shown to definitely improve not only the wearing quality, but the stability of the wheel from structural failure. It is evident that where expensive alloys are used and where special manufacturing consideration is given to a lot of wheels that there must be an increase in the manufacturing cost. This, however, is very slight in most cases, and is returned to the railway in the way of extra service, extra guarantees, etc.

The question of safety in the use of chilled iron wheels is often discussed. Safety is a relative term and whether one type of wheel is more safe than another depends on a careful record showing percentages of failures. The results in service show that no type of wheel is entitled to the distinction of being "absolutely safe" and when we begin to apply the percentage of failures, often the wheels that are supposed to be the most safe are compelled to relinquish this claim to some other type. Where the rules laid down in this article are followed, there will not be one broken wheel in one million in the chilled iron class. The study of the metallurgy of the chilled iron wheel shows the metal to be ideal for the purpose for which it is used, that is, the maximum amount of service and reliability at the least cost.

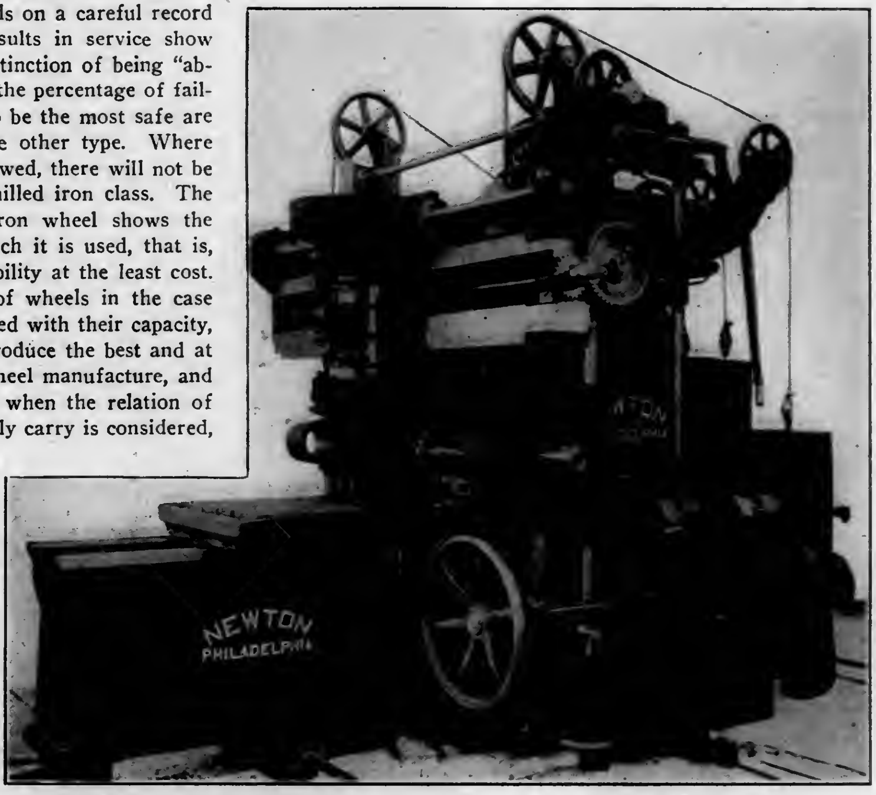
Considering the present misapplication of wheels in the case of cars of heavy braking power, as compared with their capacity, and in the adaptability of chilled iron to produce the best and at the same time the cheapest material for wheel manufacture, and on account of the reliability of the wheel when the relation of the metal to the stresses which it must safely carry is considered, we have no hesitancy in recommending the chilled iron wheel for all classes of railway service which now exist, and we see no indication of having reached the limit; in fact on account of the absence of ductility in the metal of the tread it is better suited than any other material for highly concentrated loads. For special cases, such as crane and turn-table service, where 100,000 lbs. are carried per wheel, we have no hesitancy in furnishing standard designs of chilled iron wheel.

From tests we have made, we are positive that if allowed a reasonable advance to permit greater care in manufacture and closer inspection on lines which are not now covered by standard inspection rules, and if the wheels are ordered specially for each class of service, as outlined in this paper, we can furnish not only the most economical, but the safest wheel made of any material, and guaranteed to stand any service that the strongest car or rail can carry, for any capacity or in any service, and that the proportionate ratio of comparative safety and wear will increase in proportion with the load.

VERTICAL AND HORIZONTAL MILLING MACHINE

It will be noted that this machine has about all the features that can be desired for general utility, yet is very flexible in its operations, and is therefore adapted to the different classes of work in railroad shops on account of the convenient location and small number of operating levers, and the fact that one transmission serves for all the moving parts. The machine is also so designed that the side head can be placed on either side, the right or left hand upright, or one on each upright, and two on the cross rail.

The diameter of the spindles in the adjustable saddles is 4 in.; in the sleeve of the driving worm, 3⅝ in.; independent hand adjustment to spindles, 8 in., and diameter of spindle driving worm wheel, 19 in. The maximum distance between the uprights is 45 in.; maximum height under vertical spindle, 25 in.; maximum height center of horizontal spindle to top of the work table, 17 in.; and maximum distance between horizontal spindle and opposite upright, 36 in. Both spindles are identically of the same design, and revolve in bronze bushed capped bearings in the saddles, having vertical hand adjustment with micrometer measuring guides, and are driven by sleeve worm wheels by means of double splines. The driving worm wheels have a bronze ring with teeth of steep lead and hardened steel, and the driving worm is of hardened steel fitted with roller thrust bearings, both of which are encased and run in oil. Special provisions to prevent the escape of oil are made, the flange being cast solid with the saddles, extending 2 in. beyond the hub on



LATEST DEVELOPMENT IN NEWTON MILLING MACHINE.

the driving worm, and the driving spline shafts are fitted with bushings that revolve with them, preventing the escape of oil through the splines, as would occur if the shafts had a direct bearing on the bushings.

The spindles are arranged to drive the cutter arbors by means of a broad faced key, and to hold these in place by a through retaining bolt. The spindle saddles are arranged with the new Newton system, which has the adjustment by means of taper shoes, putting the stress only on each edge of one shear for each surface, thus overcoming the distortion of surface which existed under the previous practice of having the bearings on both outside edges of the rail or uprights. The horizontal spindle saddle and outboard bearing are counterweighted, have hand vertical adjustment by means of a rack placed on the front of the uprights, and the adjacent faces of the spindle saddle and outer bearing, and of the rail, are finished, permitting of their attachment to maintain alignment when using an arbor in a horizontal spindle or for their elevation by power in unison with the rail. The drive for the vertical spindle is clutched, and by this means either of the spindles can be run independently, or they can be operated in unison as desired. Motion for the feed and fast power traverse is taken from a double train of bevel gears shown on the right hand side of the machine, to the feed and speed box, which is the standard Newton construction. The drive for the vertical spindle can be engaged or disengaged from either side of the machine.

The cross rail is of box type construction; is counterweighted; has reversing fast power vertical adjustment, and feed with nine changes, and the alignment is maintained by having a bearing on both sides or only one shear. On the right hand up-

right, elevating screws have a top and bottom bearing to permit of their always being maintained in tension; as the counterweights are heavier than the rail all lost motion is eliminated.

The work table has square locked gibbed bearings on the base, and the drive is by means of an angular rack and spiral pinion; there are nine changes of reversing gear feed, and fast power transmission serves for operating the table for the elevation of the rail, and for imparting reversing feed and fast power traverse to the vertical spindle on the cross rail.

The length of the work table is to mill 7 ft., but this can be made any length to suit requirements, and the dimensions of the machine over all is 9 ft. in length and 11 ft. in width over motor brackets and extending levers. The rack on this table is of steel, and the engaging pinion is of bronze; the motor has a speed of 440 to 1,400 r.p.m., giving spindle speeds to the horizontal spindle of 13.73 and 43.70 r.p.m., and to th vertical spindle 11.11 and 35.61 r.p.m. The feeds of the table per revolution of vertical spindle is .0349 in. and .3615 in., and to the horizontal spindle from .0285 in. to .2945 in. The table feeds per minute range from .3915 in. to 4.05 in. on the slow speed of the motor, and from 1.245 in. to 12.90 in. on the high speed. The quick movement to the table is 66.25 in. on the slow speed and 17 ft. 7 in. on the high speed of the motor. The quick movement per revolution of the horizontal spindle is 4.82 in., and per revolution of vertical spindle is 5.91 in.; the cross feed to the vertical head on rail per revolution is .0392 in. to .406 in., and the down feed to the rail is .0468 in. to .485 in. per revolution of vertical spindle.

Motion for driving the machine is transmitted from the motor mounted on the pad through the new design of General Electric rag pinion to the driving spur gear, a bevel gear transmitting motion to the vertical shaft, also to the horizontal shaft running through the bed for driving the right hand head. This machine will weigh 30,000 lbs. net, and is the last recently shipped to the Australian Railway Commission.

CONTRACTORS ARE RUSHING WORK ON THE NEW UNION STATION in Baltimore, and according to Gamble Latrobe, general agent of the Pennsylvania Railroad in Baltimore, the structure should be completed about April 15. It is expected that the connecting street bridge will not be completed until some time later, but the road has been practically assured by the contractors that the new building will be turned over by the middle of April.

FOR HARDENING HIGH-SPEED TOOLS the barium-chloride process has many advantages. Commercial barium-chloride, to which about 2 per cent. of sodium carbonate has been added, is melted in a graphite crucible and raised to a temperature of from 2,000 to 2,125° F. The tool is kept in the bath until it attains the temperature of the bath, and is then quenched, preferably in an oil-bath.

THE SUPREME COURT OF GEORGIA has rendered a decision sustaining the constitutionality of the state law passed in 1908 requiring the railroads to equip all their locomotives with electric headlights. It was given in a test case, the Atlantic Coast Line having refused to obey the law, and upon conviction of its violation was fined $250.

"THE RULE OF THE ROAD WILL BE TO KEEP TO THE RIGHT," was the order issued by division superintendents of the Lake Shore Railroad from Buffalo to Chicago, which required an expense of $750,000 to make necessary alterations in signals, switches and stations.

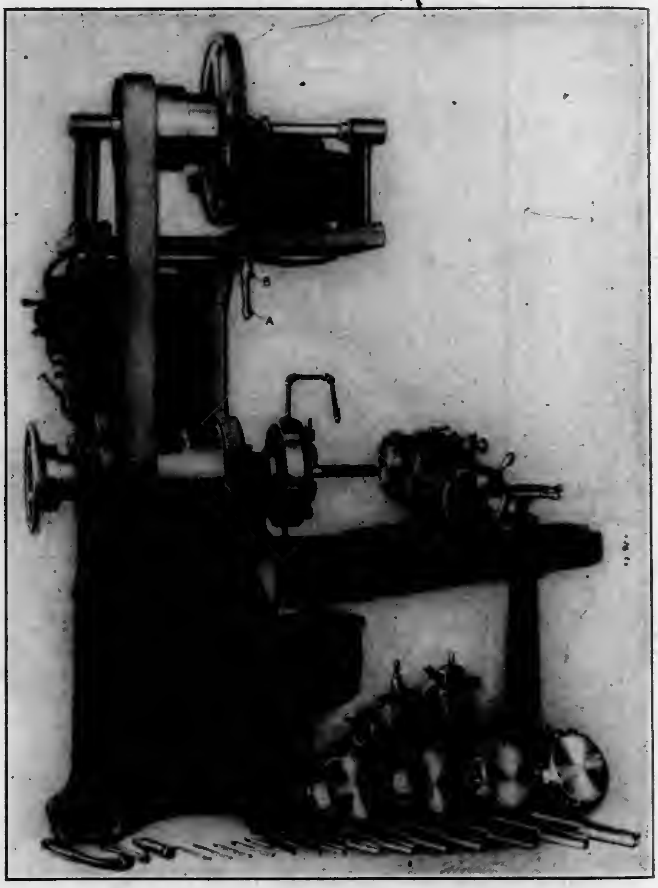
THE SIXTY-THIRD MEETING of the American Society of Mechanical Engineers will be held in Pittsburgh, Pa., from May 30th to June 2nd, inclusive. The Society has not met in that city since 1884.

THE LEHIGH VALLEY RAILROAD has decided upon the policy of applying steel underframes to all freight cars passing through its shops hereafter for general repairs.

MOTOR DRIVEN BOLT CUTTER

A striking example of development in connection with the indispensable bolt cutter is shown in the accompanying illustration which represents the latest output in that line of the Wiley and Russell Mfg. Co of Greenfield, Mass. This machine is something entirely new, and combines the features of an opening-die bolt cutter, nut tapper, pipe-threader and cutting-off machine, with the addition of electric motor drive. The drive is attached to a standard machine and forms the feature of main interest.

In the arrangement of the drive it will be noted that a bracket is fitted and bolted to the bed on which the motor shelf

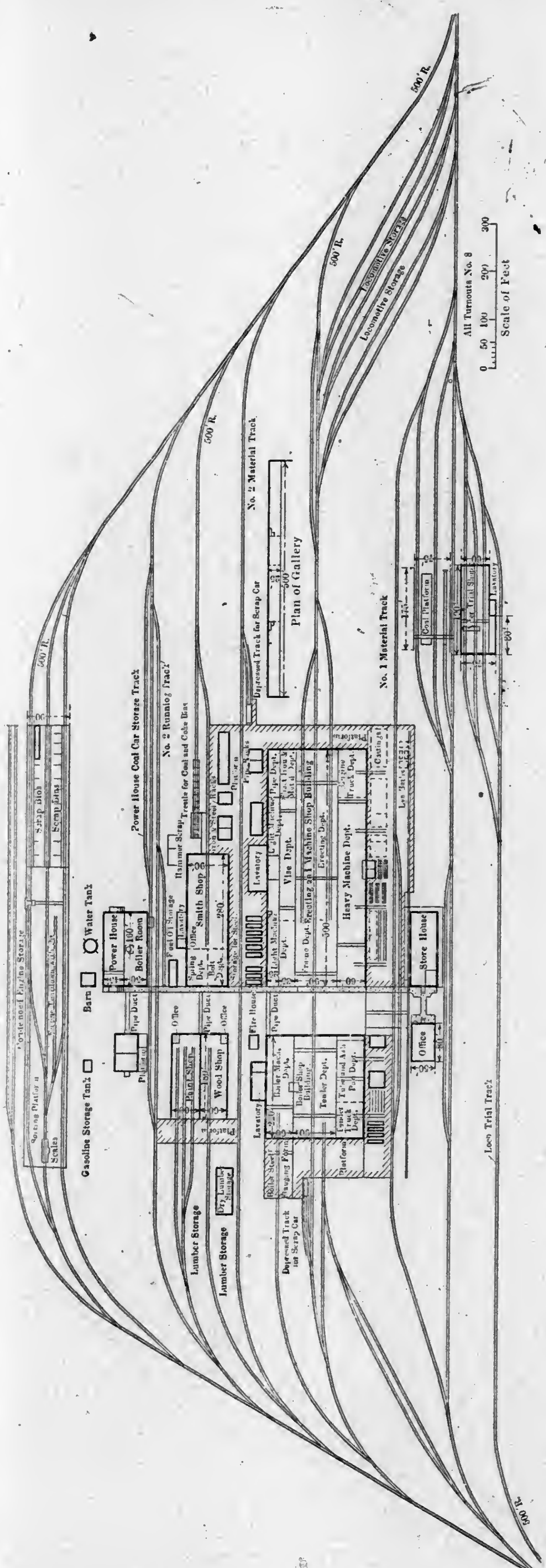


APPLICATION OF MOTOR DRIVE TO BOLT CUTTER.

is secured. This shaft is hinged at the back and has finished projecting lugs which rest on the cam shaft operated by the lever (A). By this sufficient tension can be kept on the belt at all times and the belt can be slackened off when desired to shift it from one step to another on the cone pulley. After the belt is tightened the cam shaft is locked with a binder. The lever (B) in front of the motor controls the clutch in the large spur gear so that the bolt cutter can be stopped independently of the motor. The latter, which is of two horsepower, is constant speed and back geared, and is fitted with a rawhide driving pinion. The motors are furnished for direct or alternating current, reversing or non-reversing.

It is quite apparent from a study of the design that the entire arrangement is strongly and carefully fitted, the machine being guaranteed in fact to cut bolts and pipe to two inches in diameter. The weight of the machine with motor complete is 2,300 pounds.

THE BOSTON & ALBANY already has in successful operation telephone equipment covering the whole of its main line and all branches from Boston to Albany. On these four circuits, extending 390 miles, there are 165 stations.



A GENERAL LAY-OUT FOR A MODERN LOCOMOTIVE REPAIR PLANT

At the January meeting of the New York Railway Club a paper was presented by H. H. Maxfield, master mechanic of the Trenton shops, Pennsylvania Railroad, on the "General Lay-out for a Modern Locomotive Repair Plant," which was listened to attentively and occasioned considerable discussion. The paper outlined an assumed terminal to meet certain conditions, one of sufficient capacity to turn out 75 locomotives per month with general repairs from 25 engine pit spaces.

The general assumptions were first, number of locomotives to be maintained, 750; average weight of locomotives, 80 tons; character of territory served, generally level; character of traffic, mixed—high speed passenger, local passenger, fast freight and slow freight. Under such conditions as set forth by the author, 120 per cent. of the locomotives would pass through the shop for repairs each year, these repairs varying from a new firebox and general repairs to machinery, to repairs such as renewal of broken parts, repairs due to wreck, or heavy running repairs which are not usually attempted in the ordinary roundhouse. These requirements dictated the arrangement of the layout which accompanied the paper and is reproduced herewith.

The following abstracts from the paper were accorded the principal discussion:

The first thing to be determined is whether the erecting shop should be of the longitudinal or cross-type. It is not the intention to enter upon a discussion of the relative merits of the cross and longitudinal erecting shop. The writer has found that, as a rule, the opinion held depends to a great extent upon whether past experience has been with a cross or with a longitudinal shop. I do not like to pass this point, however, without expressing a preference for the longitudinal shop, and passing over the questions of cost, floor space, cranes, etc., give as my reasons:

First, greater flexibility; second, more economical use of track space; and third, greater output from a given amount of track space.

After repairs to a locomotive have been completed it is necessary to fire it up and thoroughly try it out in order to develop minor defects. If a roundhouse is available this work is generally taken care of at that place. In case of the central shop, however, it is possible that the nearest roundhouse is too remote to allow this being done, and furthermore, it may be under different jurisdiction. Assuming the above to be the case, it becomes necessary to provide for this after-trial work at the shop proper. To bring the locomotive back into the erecting shop involves a serious delay to the legitimate work of that department, it being necessary to hold track space in reserve, which prevents bringing other locomotives into the shop, which not only reduces the efficiency of the department, but reduces the earning capacity of the men. Furthermore, the escaping smoke and gases are very objectionable.

The only satisfactory way to handle this after-trial work is to provide a separate building for this purpose, making it an auxiliary to the erecting shop, and under the supervision of that department. This auxiliary shop, or after-trial shop, as I prefer to call it, should be reasonably close to the erecting shop, and yet far enough away to prevent the escaping smoke and gases from flooding the other buildings. It should be adjacent to the track over which incoming engines pass, and also adjacent to the track on which engines are tried. Alongside of this building should be a coal platform and an ash pit. If we locate this building about 200 ft. from the far end of the erecting shop, and about 200 ft. to one side of it on the storehouse track, the various conditions mentioned will be met. The after-trial shop should be rectangular in shape and should have three tracks running through it each track being long enough to accommodate two engines with their tenders. This building should be equipped with wheel pits and an overhead traveling crane.

A considerable portion of the paper is devoted to a consideration of the arrangement, dimensions and floor space of the various buildings included in the proposed lay-out, which, however, are apparent from a study of the drawing herewith. There is nothing extraordinary in connection with the layout as presented, and it is not expected that the sizes of the various buildings given thereon will be correct for all conditions, even assuming that the number of locomotives to be maintained is the same. As explained by Mr. Maxfield the main idea of the paper is to develop a general plan, and he avers that this general plan will fit all conditions up to the point where the number of locomotives to be maintained is so large that any one plant of any design, large enough to handle them, will be unwieldy and therefore inefficient. The layout is, however, sufficiently self-explanatory to readily present the intent of the author. It is quite clear from a casual examination that ample facilities have been provided to take care of the repairs mentioned at the beginning of this review.

Principal interest in the discussion which followed the presentation of the paper centered in a consideration of the relative merits of the transverse or the longitudinal shop, and on the merits of the so-called after-trial shop. Opinion as usual was divided on the first proposition; the transverse arrangement was commended by Mr. Westley, of the Philadelphia and Reading

Ry., and rather severely criticised by Mr. Chambers, of the New Jersey Central R. R. The remaining comment on this question was largely non-committal, but the consensus of opinion, and obviously the correct attitude, is to resort to the one best indicated by conditions.

The question of the after-trial shop proved of much interest to the auditors and the suggestion generally met with much favor. It was believed that locomotives repaired at a central shop should be turned over to the various divisions where they belong ready for service, not ready for trial. Even if a roundhouse is present in connection with the central shop it was agreed that the burden and expense of careless workmanship or unavoidable defects should be upon the shop, and not upon the roundhouse organization. This plan was endorsed by Mr. Flory, of the New York, Ontario and Western Ry., and excepted to by E. O. Elliott on the following grounds:

"I want to take exception to the after-trial shop which has been considered one of the salient points in this paper. I remember a shop where they had an after-trial department and engines which were repaired were standing around for a week or a week and a half afterward, while they were needed in service. This shop was then in its first stages of organization, so finally they did away with the after-trial features, and disciplined the organization so that the engines, when they left the shop, were ready to go into service without much time being spent tinkering on them. Now we feel that the moral effect of having somebody go over the work after it has been completed and fix up the defects is something to be considered. I see the point is made that the after-trial shop would be under the control of the superintendent or master mechanic. Therefore he is responsible in the end. But so long as human nature is human nature, if we have this after-trial shop, those working in the different departments will be anxious to get rid of the work as soon as possible and shove it off on the after-trial shop."

The subject of the after-trial shop is in reality the most important consideration presented in the paper. It is a point which, although it crops up with surprising regularity, still remains undecided, and it is to be regretted that it was not accorded a more extended discussion. On the whole, Mr. Maxfield's paper is to be commended in that it introduced subjects which are of timely interest without mere adherence to the question of a speculative shop layout.

Pennsylvania Railroad Reduces Fire Losses.—The annual report of the Insurance Department of the Pennsylvania Railroad system, recently issued, shows that the company's losses by fire in 1910 were $280,097, as compared to $402,615 in 1909—a reduction of almost a third. In the past few years the Pennsylvania Railroad has redoubled its efforts to prevent fires along its lines. Many corps of employees have been trained in fire fighting, until to-day the company's own organization of firemen extends over the entire system, in every station, roundhouse and shop. In addition, yard locomotives have been equipped for fire fighting service in congested districts. That the company's methods are proving efficacious is indicated by the fact that in 1910 there were 379 fires on the property extinguished with the railroad's fire apparatus and by the company's own employees, with only a loss of about $18,000. In 1909 there were 321 fires extinguished by company apparatus and employees and the loss was approximately $20,000.

Railway Accidents Abroad.—A. L. Mohler, vice-president and general manager of the Union Pacific, returning from a tour of Europe, finds occasion to take exceptions to the general belief abroad that there are a great many more train wrecks in this country than there are anywhere in Europe, which he declares is entirely unfounded. In his trip Mr. Mohler discovered that the same conditions of railroading obtain there that are found here, and he believes, personally, that there is an even greater average of accidents.

SOLID ADJUSTABLE DIE HEAD

The Landis Machine Co., of Waynesboro, Pa., has recently brought out a new type of die head known as a "Solid adjustable Die Head." The purpose of this is to take the place of the solid dies now in use on any of the screw machines and other types of machines where the work is backed out of the die after the thread is cut. The die head is illustrated herewith, showing the 1 in standard size which has a range from ¼ to 1 in.

The die head is held in the turret of any ordinary screw machine, and trips off by retarding the forward motion of the carriage. It is also made without the tripping device for special requirements. The tripping arrangement is such that when the desired length of thread is cut, the die head will trip and revolve with the work until the machine has time to reverse. The dies are made from high speed steel and can be ground and re-ground many times, thus giving a life much greater than a solid die, besides never requiring to be annealed, hobbed or retempered, and they are readily adjustable to take up wear in addition to the adjustment for different diameters.

A NEW DIE HEAD.

One set of chasers can readily be set above or below their rated diameter. For instance, ½ inch (13 thread) can be set to cut 1 in. diameter when desired, or they can also be set to cut ¼ in. diameter. The angle in the thread, however, will not be quite ideal, but all that is required for ordinary screw machine work. With other types of die heads a special set of chasers is required every time it is desired to cut other than standard pitches. With this head any diameter within the range of the head can be cut with one set of dies so long as the pitch is the same. In very special cases where absolutely correct pitch is required, it would be advisable to use special holders so as to set the chasers on the exact angle to correspond with the angle of the thread, but ordinarily this is not required. Chasers can at all times be ground to suit the material to be cut; any amount of rake can be given that is necessary, thereby insuring the best possible cutting condition and securing ideal results.

The special advantages with this type of head are that it will admit of very much increased cutting speeds over others, has a life many times that of any other, has a wide range, any one chaser of a set can be adjusted independently of the others, if necessary, and each grinding of the dies gives all the qualities of a new die. Any chaser of a set can be replaced without replacing the complete set. By using this die very high cutting speeds are readily acquired, equal to the turning and drilling speeds on the other operations of the screw machine, so that the speeds need not be reduced in the threading operation for the accommodation of the die, as is the case with the solid dies.

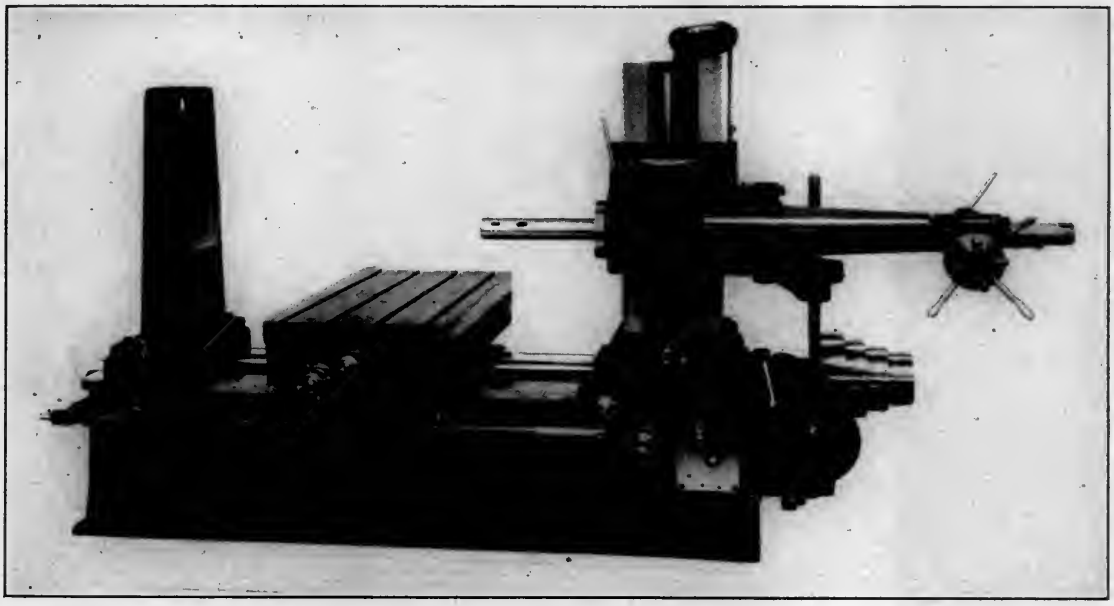
HORIZONTAL BORING, DRILLING AND MILLING MACHINE FOR WIDE RANGE OF WORK

In the design of this machine the Fosdick Machine Tool Company has embodied several features of interest, such as a deep bed of great rigidity, which makes the machine self-contained and a foundation unnecessary, and insures perfect alignment of the table with the spindle and outer support at all times. All the gears are of steel, of heavy pitch; all bearings are large and bronze bushed, and all moving parts are covered. A mere cursory examination of the design creates at once the impression of unusual strength combined with a compactness seldom observed in connection with this particular tool. It is especially adapted for hard service under varying conditions, and appears to be particularly suitable for the requirements of railroad machine shops in general, where a boring mill of larger dimensions would be unnecessary.

The drive in this machine is either through the cone or speed box. A four step cone pulley is used, the largest step of which is 14 in. by 3¼ in., permitting the use of a 3 in belt. The speed box is provided with eight changes of speed, all instantly available. Both cone and speed box drives can be started and stopped from the front of the machine by a conveniently located lever. The machine can be reversed by the use of a reversible countershaft. The spindle head on outer support for the boring bar are raised and lowered simultaneously by power or hand. It is fitted with an automatic safety trip to prevent any accident due to carelessness. The spindle is of crucible steel, accurately ground, and is fitted with a Morse taper. It passes through a soft iron sleeve and is driven by a large key. The thrust is taken up on ball bearings.

The sleeve runs in bronze bearings and carries the driving gear. It is equipped by a device whereby the spindle can be kept in line after any amount of wear. The front of the sleeve forms a face plate to which milling cutters, facing heads or other tools may be attached, thereby relieving the spindle bar to a large extent, and also eliminating chattering when using large milling cutters. The table is of heavy construction, has T slots planed in it, and is scraped absolutely square with a line passing through the center of the spindle. An automatic safety stop is provided here also to prevent breakage due to the carelessness of the operator. It has a longitudinal motion by hand and a cross motion by hand or power. There are eight changes of feed, all reversible, which are obtained through one box.

Adjustment of the spindle head, platen and outer supports is made by screws accurately spaced. The ends are provided with micrometer collars, graduated to .001 in., making it possible to bore, drill and mill surfaces to exact distances apart without the use of jigs, which makes it an invaluable machine for the tool room or wherever great accuracy is required. The workmanship and material are the best obtainable, and are guaranteed throughout. The floor space is 13 ft. 8 in. and the approximate net weight is 7,700 lbs.



POWERFUL HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

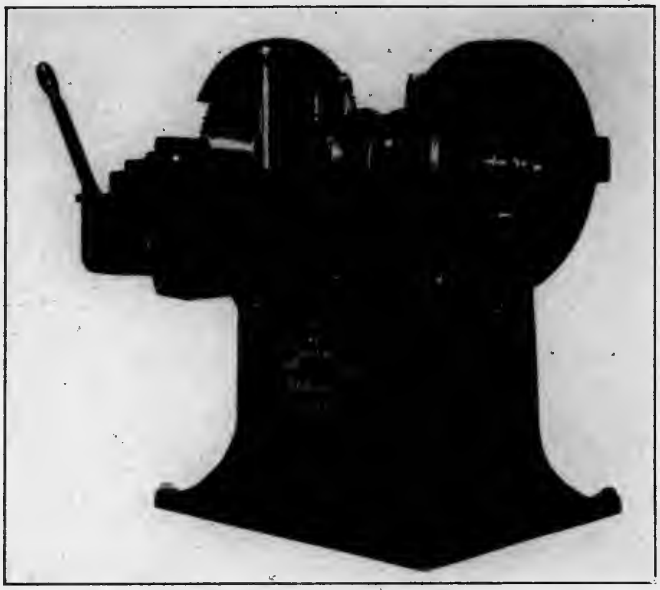
THE PENNSYLVANIA'S RELIEF FUND SYSTEM

More than two and one-quarter million dollars in benefits were distributed during the year 1910 to members of the Relief Funds of the Pennsylvania Railroad System, according to a report recently issued by the company. The membership of the Funds on December 31st, 1910, was 162,052, or nearly 85 per cent. of the total number of employes in the service. Some idea of the extent of the work of the relief departments can be had from the fact that during the past year payments to the families of members who died amounted to $839,750.87, while $1,449,967.42 was paid to members who were unable to work. Since the Relief Funds for both the Lines East and West of Pittsburgh were established some 25 years ago, $11,949,213.01 has been paid to the families of members who died, and $17,814,217.49 to members unable to work, or a total distribution to December 31st, 1910, of $29,763,430.50.

The report recently issued shows that during the month of December alone the sum of $192,124.73 was distributed to members of the Pennsylvania Relief Funds who had become incapacitated for work on account of sickness or accident, and to the families of members who died. In December, on the Lines East of Pittsburgh and Erie, the payments in benefits to the families of members who died amounted to $61,408.03, while to members incapacitated for work they amounted to $78,640.95. The total payments on Lines East of Pittsburgh since the Relief Fund was established in 1886 have amounted to $21,644,748.84. The Relief Fund of the Pennsylvania Lines West of Pittsburgh paid during December a total of $52,075.75, of which $12,937.50 were for the families of members who died, and $39,138.25 for members unable to work. The sum of $8,118,681.66 represents the total payments of the Relief Fund of the Pennsylvania Lines West of Pittsburgh since it was established in 1889.

HOT SAW AND BURRING MACHINE

One of the most interesting and useful machines recently placed on the market for the forge shop equipment is a hot saw and burring machine manufactured by the Ajax Mfg. Co., Cleveland, Ohio. This machine has been designed and is intended primarily for service in connection with an upsetting forging



THE AJAX HOT METAL SAW.

machine, a complete line of which machines the same company manufactures, and the designing and marketing of this machine has been prompted by the desire of the manufacturer to further economize in the production of machine-made forgings By the use of a hot saw and burring machine the headed forging may be sawed off the bar immediately after it is upset, thus leaving a clean, square end, and likewise the burrs or fins which are formed after a set of dies have been used, can be removed very readily.

The machine as shown in the illustration herewith is similar in general design to a double ended grinding or emery wheel stand. On one end of the shaft is a head fitted with a milled band and a milled disc face. This end is used for removing the fins or burrs from the upset forgings. The opposite end of the shaft carries a hot saw for cutting off the forging from the bar. These machines are built in three sizes, with 14-in., 20-in. and 30-in. diameter of saws and burring heads. They operate at a high rate of speed and are consequently built rigidly with large bearings and ample provision for lubrication. The utility of such a machine will be fully appreciated by users of upsetting forging machinery.

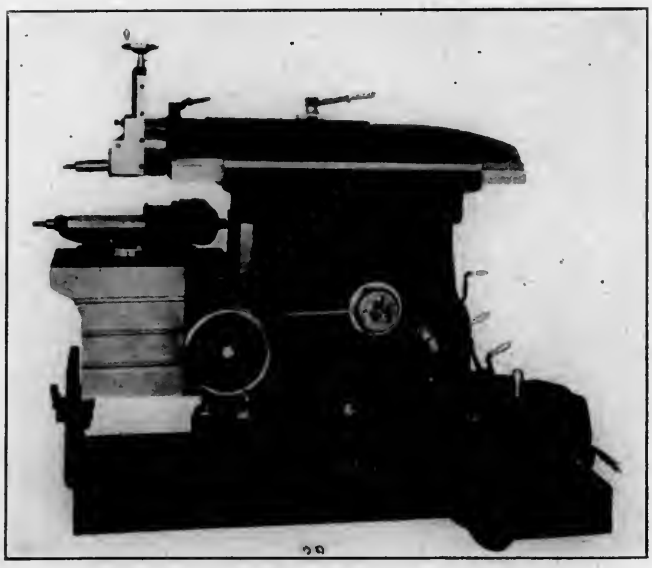
REMARKABLE RECORD ON HARRIMAN LINES.—The Harriman lines carried 10 per cent. of the estimated 1910 passenger traffic of the United States, or 49,491,000 people, without fatal accident to any of the number. The report, containing this data, just has been compiled in the offices of the director of maintenance and operation, and covers the total system of some 17,960 miles. The total number of passengers carried on a one-mile basis was 3,000,000,000. The figures of the country's railroads for 1910 have not yet been compiled by the government, but in 1909 the Interstate Commerce Commission reported the number of passengers carried as 29,000,000,000. In the year 1903-1904 the number of accidents on the Union Pacific was 20 for 1,000,000 locomotive miles. In the final half of 1910 it was only .4 for 1,000,000 locomotive miles. On the Pacific system of the Southern Pacific the number of accidents per 1,000,000 locomotive miles was reduced in the same time from 20.5 to 10.5.

BACK GEARED CRANK SHAPER WITH MOTOR DRIVE AND SPEED BOX

This handsome and substantial tool is the latest production of the John Steptoe Shaper Co., of Cincinnati, O., and it embodies several distinctive features which entitle the design to a careful study. In particular the drive, which is very simple, consisting of a small gear on the motor with a large gear on the speed box shaft, is of particular interest. The motor is set on a subbase, cast on the base of the shaper, and therefore rests on a very solid foundation, and avoids the possibility of shaking the machine when running.

Four changes of speed are secured through the speed box, and by means of the back gears eight changes are secured. The speed box is so arranged that no clutches are used, and therefore no gears run idle on the shaft. When one gear is shifted in position, the other is shifted out, thereby making a very effective drive and reducing the wear to a minimum. All the bearings in the speed box are equipped with ring oilers which keep the shafts constantly flooded in oil. Spiral oil channels are chased in the shaft to insure the proper distribution of the oil over the entire bearing. A large bush is provided where the driving shaft from the shaper enters the speed box. This bush enters the column of the shaper and also the speed box bearing. The driving shaft is therefore relieved of any possible strain that might come from the speed box, as such strain would come directly on the bush provided for that purpose. This bushing is equipped with ring oilers, both in the column of the shaper and in the speed box. The intermediate shaft in the shaper is also provided with ring oilers and bushings which can be readily removed and replaced at any time should it become necessary.

The machine can be stopped or started by means of a clutch which operates in the hub of the large gear. One pound pressure on the clutch lever gives 128 pounds pressure on the ring, so that the starting operation can be effected by an almost imperceptible effort. It is advanced, in fact, that this can be effected by means of the thumb and first finger of the right



NEW STEPTOE SHAPER.

hand. All of the clutch mechanism is fully enclosed, thus avoiding any possibility of accident to the operator.

It is clearly apparent, from a study of this machine, that the drive, irrespective of other points of superior merit, is so simply constructed that there is in reality nothing pertaining to it which could become out of order. It is a sensible and practical machine throughout, and fully maintains the reputation of its builders.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 7	Railway Signalling	L. R. Clausen	Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	Mar. 10	Influence of Gravity on Trains Descending Grades and the Power Necessary for Safe Control	J. P. Kelly	H. D. Vought	95 Liberty St., New York
New England	Mar. 14	Revision of Rules of Interchange		Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Mar. 17	Seventh Annual Electrical Night		H. D. Vought	95 Liberty St., New York
Pittsburg	Mar. 24	Revision of Rules of Interchange	Committee Report	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Mar. 10	....	Maj. Geo. Hine	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Mar. 10	Not announced	Col. R. V. Taylor	B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	Mar. 21	Electrification of Chicago Terminals	C. A. Seley	Jos. W. Taylor	390 Old Colony Bldg Chicago
Western Canada	Mar. 13	Should a Railroad Have a Trouble Department?		W. H. Rosevear	100 Chestnut St., Winnipeg, Man.

STANDARDIZATION OF CHILLED IRON CAR WHEELS.

WESTERN RAILWAY CLUB.

W. S. Killam presented one of the most valuable papers that has been read before any of the clubs this year, at the January meeting of the Western. This paper is too important to be reviewed in the space permitted here and is therefore reprinted in abstract in another part of this issue.

TRANSPORTATION OF DANGEROUS ARTICLES.

NEW ENGLAND RAILROAD CLUB.

At the January meeting Col. B. W. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, presented practically the same paper he has read before many other railway clubs during the past year on this most important and interesting subject. It was fully illustrated with lantern slides.

APPRENTICESHIP.

WESTERN CANADA RAILWAY CLUB.

At the January meeting it was decided that Mr. Gower's paper on "Apprenticeship," which had been presented at a previous meeting, should not be allowed to go without further efforts on the part of the club to put the ideas suggested into operation, and it was decided to appoint a committee who should interview the managements of the various railroads in that district to see if some action could not be taken by these roads to further the modern ideas of apprenticeship training. The committee appointed consisted of the following gentlemen: S. J. Hungerford, W. E. Woodhouse, A. H. Eager, G. W. Robb and T. G. Armstrong.

S. A. Gidlow, general secretary of the St. Johns Ambulance Association, Canadian Pacific Railroad, presented a paper on "First Aid to the Injured." This paper pointed out the value of first aid knowledge in all conditions of existence—particularly in hazardous occupations, around shops, etc. It explained the course of lectures, giving a syllabus, that are given to the classes now being organized among all classes of employees throughout the Canadian Pacific Railroad System. These classes are very carefully conducted and examinations are given to assure a correct understanding of the work. There are now 51 classes, consisting of 1,607 men, in operation on the various divisions.

This paper aroused a most interesting discussion and many points of interest and value were brought out.

GENERATION AND DISTRIBUTION OF ELECTRIC POWER AND ITS APPLICATION TO RAILROADS.

CANADIAN RAILWAY CLUB.

F. Darlington, chief engineer of the Railway Department of the Westinghouse Electric & Manufacturing Co., at the February meeting of this club presented a most interesting and instructive paper on the application of electricity to railroad service. In a very clear manner he pointed out the predominating importance of the load-factor of the power station on the unit cost of output. Assuming that the power plant is used exclusively for transportation purposes the power factor must of necessity be very low unless a tremendously expensive storage battery equipment is installed, as has been done by the New York Central Lines. Costs of current at the switchboard under various assumed conditions were given to illustrate this feature.

The impression gained from a reading of this paper is that Mr. Darlington does not favor the electric operation of railroads in general unless other features than economy are the controlling ones. This idea is based on the poor load factor and does not hold if it is possible to either purchase current from an outside source or to have sufficient uses outside of transportation for current from a central power station to give it a satisfactory load factor. This in many cases can be done with not only direct economy on the transportation costs, but also an improvement on the manufacturing conditions in the neighborhood.

THE EFFICIENCY OF TOOLS AND ECONOMY IN MANUFACTURING THEM.

CANADIAN RAILWAY CLUB.

W. M. Townsend, supervisor of tools, Montreal Locomotive Co., presented a very valuable paper at the January meeting of this club on the manufacture of tools. The subject of milling cutters was first considered in detail and the best design and proper method of handling in the manufacture were very clearly indicated. It was stated that cutters having a diameter much less than 6 in. should not have inserted teeth, but above that size inserted teeth were often advisable. The cost of the different kinds of steel suitable for this use was discussed, as well as the proper size and shape. Next the author considered the regular list of tools used on lathes, planers, etc., and stated that a great saving can be made by using a piece of billet steel for the body of the tool and welding a tip of high speed steel at the cutting edge. The methods of doing this were very clearly explained in detail. Drills were then considered in much the same manner as were also reamers. Attention was drawn to the importance of having an accurate distribution of tools in order to obtain the greatest economy. This should be under the control of a specialist who also is the expert on tool design and manufacture, and should not be left to the tool room foreman, whose duties prevent him from properly following up the use and abuse of the various tools issued.

THE JACOBS-SCHUPERT UNITED STATES FIRE BOX COMPANY, Coatesville, Pa., has applied for a charter under Pennsylvania laws. Those interested are A. F. Huston, Charles L. Huston and Joseph Humpton of the Lukens Iron & Steel Company, together ith a number of officials of the Atchison, Topeka & Santa Fé Railroad. The company controls the patents and has erected and equipped a plant at Coatesville for the manufacture of the Jacobs-Schupert fire boxes for locomotives, invented by Henry W. Jacobs, assistant superintendent of motive power of the Santa Fé Railroad, and Frank W. Schupert.—*Iron Age.*

PERSONALS

HARRY D. BISHOP has been made roundhouse foreman at Belen, N. M., vice C. C. Brooks.

C. M. WHITNEY has been made general foreman of the 'Frisco shops at Cape Girardeau, Mo.

C. C. SHEPHERDSON has been appointed assistant foreman of the Santa Fe at Albuquerque, N. M.

L. L. COLLIER has been appointed foreman of the Santa Fe at Ashfork, Ariz., vice J. Williams, resigned.

H. S. LLOYD has been made master mechanic of the Tennessee, Alabama & Georgia R. R., at Alton Park, Tenn.

GEORGE SPRATLEY has been made master boilermaker of the Colorado Midland R. R. at Colorado City, Colo.

W. C. RADKE has been appointed master mechanic of the Northern Pacific R. R., with headquarters at Staples, Minn.

E. L. RICHARDSON has beeen appointed general foreman of the Norfolk and Western Ry., with office at Roanoke, Va.

CHARLES MANLEY has been appointed superintendent of shops of the National Railways of Mexico, with office at Aguas Calientes.

D. L. RINGLER has been made roundhouse foreman of the Trinity and Brazos Valley Ry. at Teague, Texas, vice E. L. Critz, transferred.

J. B. KILPATRICK has been made superintendent of motive power of the first district of the Rock Island system, with office at Chicago.

S. W. MULLINIX has been made superintendent of motive power of the second district of the Rock Island system, with office at Topeka, Kans.

C. M. TAYLOR has been made superintendent of motive power of the third district of the Rock Island system, with office at Shawnee, Okla.

C. A. WOOD succeeds C. W. Tessier as general foreman of the car department, National Railways of Mexico, with office at Aguas Calientes.

J. E. HENSHAW has been made superintendent of the St. Louis & San Francisco Ry. shops at Springfield, Mo., succeeding T. W. Lillie, resigned.

T. M. PRICE has been made superintendent of the shops of the Detroit, Toledo & Ironton at Jackson, Ohio, vice H. F. Martyr, resigned as general foreman.

V. W. ELLET has beeen appointed a general foreman of the Rock Island Lines, with office at Rock Island, Ill., succeeding J. E. Loy, assigned to other duties.

E. T. MILLER, general foreman of the Concord shops of the Boston & Maine R. R., has been appointed general car inspector with office at Boston, Mass.

G. S. HUNTER has been appointed a master mechanic of the Missouri, Oklahoma & Gulf R. R., with office at Muskogee, Okla., succeeding J. F. Grealy, resigned.

J. W. SMALL, superintendent of machinery of the Kansas City Southern R. R., at Pittsburg, Kans., has had his authority extended over the Arkansas Western R. R.

W. J. JOLLERTON has been appointed assistant general superintendent of motive power of the Chicago, Rock Island and Pacific Ry., with headquarters at Chicago.

N. S. BROOKS, general foreman of the Baltimore and Ohio R. R. at Keyser, W. Va., has been appointed assistant master mechanic, with office at Cumberland, Md.

E. O. ROLLINGS, assistant master mechanic of the Louisville and Nashville Ry. at Howell, Ind., has been promoted to be master mechanic, with office at So. Louisville, Ky.

T. M. PRICE, assistant master mechanic of the Detroit, Toledo & Ironton Ry., at Jackson, Ohio, has been appointed general foreman, with office at Jackson, succeeding H. F. Martyre, resigned.

W. G. TAWSE, road foreman of engines of the Chicago & Eastern Illinois R. R., has resigned that position and is now with the Locomotive Superheater Company, New York, with office at Chicago.

WILLIAM P. CARROLL, terminal foreman of the New York Central & Hudson River R. R., at Buffalo, N. Y., has been appointed master mechanic, with office at Rochester, succeeding F. M. Steele, resigned.

M. WEBER has been appointed master mechanic of the Albuquerque division of the Atchison, Topeka & Santa Fe Coast Lines, with office at Winslow, Ariz., succeeding William Daze, assigned to other duties.

W. G. HAMMELL, formerly chief engineer, has beeen appointed purchasing agent of the Atlanta, Birmingham and Atlantic R. R. He relieves W. D. Knott, who has been given leave of absence on account of ill health.

O. T. HARROUN has resigned as tool foreman of the Chicago & Alton R. R. and the office is abolished. Mr. Harroun is secretary of the American Railway Tool Foremen's Association, and is temporarily located at Odin, Ill.

O. S. JACKSON, master mechanic of the Chicago, Indianapolis & Louisville Ry., at Lafayette, Ind., has been appointed superintendent of motive power of the Chicago, Terre Haute & Southeastern, with office at Terre Haute, Ind.

G. L. LAMBETH, master mechanic of the St. Louis division of the Mobile & Ohio R. R., at Jackson, Tenn., has been appointed master mechanic of the Mobile division, with office at Whistler, Ala., succeeding E. G. Brooks, assigned to other duties.

J. P. MCCUEN, formerly superintendent of motive power of the Cincinnati, New Orleans & Texas Pacific Ry., and who retired recently after 30 years of service, will be retained with the road in an advisory capacity, with the title of general inspector.

JNO. A. CLARKE, of the purchasing department of the Canadian Pacific Ry. at Montreal, died on Feb. 5, aged 63 years. Death ensued from hemorrhage of the brain brought on by a fall sustained while in attendance at the funeral of the late chief engineer of the road, J. E. Schwitzer.

C. W. DIEMAN has beeen appointed master mechanic of the Green Bay & Western Ry., the Kewaunee, Green Bay & Western R. R., the Ahnapee & Western Ry. and the Iola & Northern R. R., with office at Green Bay, Wis., succeeding W. P. Raidler, resigned to engage in other business.

F. O. WALSH, master mechanic of the Atlanta & West Point R. R. and the Western Railway of Alabama, at Montgomery, Ala., has been appointed mechanical assistant to the general manager of the Brazil Railroad Company, in charge of the mechanical department, with office at Sao Paulo, Brazil, S. A.

J. W. MARDEN, superintendent of the car department of the Boston & Maine R. R., has resigned after fifty years of continuous service. The above position which Mr. Marden held since 1907, is now abolished, and the business of that department will come under the supervision of H. Bartlett, general mechanical superintendent.

WILLARD DOUD, shop engineer of the Chicago, Burlington and Quincy R. R., resigned from that position February 1, and has beeen appointed in a similar capacity on the Illinois Central R. R. Mr. Doud will give his particular attention to planning improvements in power plants, and other features of shops which come especially under the mechanical department.

GEORGE PARSONS SWEELEY, late master mechanic Allegheny shops, Pennsylavania lines, Northwest system, who died at his home in Allegheny on January 10, 1911, was very well known in mechanical circles and has been in continuous service with the Pennsylvania for more than thirty-five years. Mr. Sweeley was born in Montoursville, Pa., on July 13, 1856. He was a member of the M. M. and M. C. B. associations, the Pittsburg Railway Club, the Bellevue Club and the Masonic fraternity.

CATALOGS

VALVES.—The Nelson Valve Co., of Philadelphia, Pa., has issued a large folding leaflet illustrating and describing its various globe, angle, gate and check valves, and which contains much valuable information for users of these parts.

BALL BEARINGS.—The Hess-Bright Mfg. Co., of Philadelphia, Pa., has isssued two leaflets on magneto bearings and centrifugal basket mountings, which retain the attractive appearance so characteristic of the literature issued by this company.

LATHE EFFICIENCY.—This is the title of a very instructive catalog just issued by the American Tool Works Co., of Cincinnati, O. It deals with the facts about engine lathes and illustrates several of the prominent designs of the latter as manufactured by this company.

CONDUIT PRODUCTS.—In catalog 436 the Sprague Electric Co., of New York, presents a variety of illustrated descriptive matter in connection with its conduit products which in the form compiled becomes exceedingly valuable as a reference book for those interested in this line. The catalog, which contains 42 pages, is conveniently divided into sections, and is carefully indexed.

WIRES AND CABLES.—A very handsome catalog, entitled Bulletin No. 4787, recently beeen issued by the General Electric Co., devoted to the subject of wires and cables. The publication should be of considerable service purchasing agents, central station managers, and all having occasion to buy or use wire and cable for any service. The book contains much data, but no prices.

POWER AND LIGHTING TRANSFORMERS.—In Bulletin 451, issued by the Triumph Electric Co., of Cincinnati, O., will be found a complete description of the "Triumph Type L" transformers, and the many points of superiority which they possess are specially featured. The bulletin is well written and the various points in the description are presented in a manner which renders them particularly interested.

STEEL PLATE AND MANUFACTURED SHAPES.—The Carnegie Steel Co., of Newark, N. J., has just issued its Waverly Warehouses Stock List No. 6 which is complete with the usual information in regard to the available stock of the Carnegie Company. The pamphlet contains a very attractive map of Waverly, N. J., which graphically illustrates the enviable location of the plant in relation to its railroad facilities.

TOOL ROOM FURNACES.—Bulletin "R," recently issued by the Rockwell Furnace Co. of New York, describes a gas furnace for tool room use which is of decided interest. It in reality embodies eight furnaces in one and is thoroughly adapted for accurately heat treating small tools, etc., and for annealing, hardening, tempering and forging. This is a most compact and complete furnace and is well designated as a necessary, if not an indispensable, accessory to an up-to-date tool room.

BRAKE BEAMS.—The Chicago Railway Equipment Co. has recently issued under the title "The Railway Equipment Primer," a novel presentation of the merits of the Creco brake beam. This little book is strongly reminiscent of our old school day companions, the "Rollo Books," and its compiler, Bruce V. Crandall, has in happy vein brought some compelling points home to us. Notwithstanding its gloss of humor, however, there is a prominent truth embodied in the little book, and as the perusal of its pages progresses it becomes apparent in a way which is quite appealing. Railroad men should read this primer, and if their interest equals our own they will be well repaid.

STORAGE BATTERIES.—This attractive catalog is published in the interests of the Edison Storage Battery Co., and for the purpose of disseminating complete and useful information in regard to the new Edison storage battery. It is intended that it shall answer satisfactorily not only the questions of the novice, but of the man who knows batteries, and who is familiar with the electric vehicle. It deals principally with comparison betweeen the Edison battery and those of the older types, and without referring by name to any particular make of lead battery, all of the comparisons referred to in the catalog are based upon actual experience, and all statements may be easily verified by any competent and honest expert.

ELECTRIC SUPPLIES.—Bulletin No. 4813, just issued by the General Electric Co., describes an oil break switch adapted to use on alternating current series arc systems for sectionalizing feeder systems, cutting in and out transformers, and similar classes of service requiring a switch to be operated under load. Bulletin 4811 contains descriptive matter and data in considerable detail on drum controllers for industrial service, and supersedes the General Electric Co.'s previous bulletin on this subject. Bulletin No. 4791 describes the General Electric regulators of the induction type and switch type, single and polyphase, hand operated and automatically operated. It contains connection and dimension diagrams, together with weights of the various regulators described.

ELECTRICAL CATECHISM—DIRECT CURRENT APPARATUS.—Fairbanks, Morse & Co., Chicago, have published a very interesting booklet giving, in simple language, definitions for electrical terms and describing the construction and uses of different electrical machines. As the title indicates, this treatise is prepared in the form of a series of questions and answers. It was originally prepared for the use of salesmen only, but there has been a considerable demand for it by others. The booklet is well illustrated and printed on enameled paper. The insight which it gives to the products of Fairbanks, Morse & Co. makes it very interesting to engineers, and, to one who is not familiar with electrical machinery, this pamphlet will be of great assistance. It will be sent on request to interested parties.

TOOL STEELS.—An artistic catalog which has been recently issued by Edgar Allen & Co., Ltd., of Sheffield, is devoted to a considerable discussion of high speed steels and their application to the usual and unusual processes wherein employed. The catalog, in addition to specific information in regard to shapes and sizes of tool steel, deals somewhat exhaustively with other products of the company. It graphically illustrates all kinds of steel castings for locomotives, and the important features in connection with the Edgar Allen & Co.'s output; rails, railway crossings and switch layouts are not by any means neglected. The catalog will invite an attentive perusal, and although the company will be pleased to supplement the information if required, its completeness is such that little more can be offered.

TELEPHONE TRAIN DISPATCHING.—Bulletin No. 501, just issued by the United States Electric Co., of New York and Chicago, is designed to present accurate information in respect to the application of selective calling to railway service, and in particular to the use of the Selector Telephone System in train dispatching. The bulletin describes the development of the system and explains fully the functions and service of the Gill selector and the answer-back. The circuits and the outfits for calling with the local battery bell and the main line bell are described and illustrated and some facts regarding the economic advantages of substituting selective telephone train dispatching for the telegraph sounder call are convincingly assembled. The selector outfits to operate under the various optional arrangements are conveniently grouped, as to equipment, and designated by code numbers.

CRANES.—The Whiting Foundry and Equipment Co., of Harvey, Ill., under the title "Cranes of All Types—for Every Service," has issued a 40-page catalog which in condensed form gives a description of special features of Whiting cranes, also views of installations and list of principal customers. The intent of the catalog is to convey that there is a Whiting crane for every service and this is well borne out in the profusely illustrated matter which is a prominent feature. The great diversity in operations which are permissible are presented in a manner which endows it with particular interest. A considerable portion of the catalog is devoted to a detailed description of the component parts. The Whiting Company will be pleased to furnish a copy of the catalog on request and it will well repay a perusal by anyone interested in the subject.

LOCOMOTIVE SAFETY VALVES.—The Crosby Steam Gage and Valve Co., of Boston, Mass., has recently issued a most valuable and instructive little treatise under the title "The Measurement of Steam Discharge in Locomotive Pop Safety Valves." The book is a report of such tests as conducted in April and June, 1910, by Professor Edward F. Miller at the Massachusetts Institute of Technology to determine definitely the two important questions, "How much steam will a safety valve discharge?" and "How much will it relieve a boiler?" The report will repay careful study and analysis. For those who may have a special interest in the subject a discussion of the work is appended showing its practical application in railroad work and its value to the mechanical engineer and superintendent of motive power. The Crosby Company also issues an attractive pamphlet on the Crosby principle in safety valves for locomotives which is fully and clearly descriptive of its locomotive safety valve.

NOTES

F. W. MILLER HEATING CO.—On March 1, 1911, this company assumed occupancy of its new suite of offices 314-315 McCormick Bldg., 193 Michigan Boulevard corner Van Buren St., Chicago, Ill.

PRESSED STEEL CAR CO.—At the regular quarterly meeeting of the board of directors of this company, held January 25, 1911, O. C. Yayley was elected a director to fill the vacancy caused by the recent death of one of the members of the board.

JOSEPH DIXON CRUCIBLE CO.—During 1910 this company of Jersey City, N. J., supplied graphite and graphite lubricants to 210 different steam railroad companies. Its business with the steam railroads increased 53 per cent., and during the same period it sold the same products to 91 automobile manufacturers, increasing its business with them 260 per cent.

BURTON W. MUDGE & CO.—This company, of Chicago, Ill., have added materially to their well equipped organization by electing Thomas A. Garland a vice-president. The attention of Mr. Garland will be directed to the development of car ventilating and refrigerating devices, patented by him while superintendent of refrigerator service of the Burlington system.

WELLS BROTHERS CO.—Announcement is made by the above company of Greenfield, Mass., that Edward Blake, Jr., who has been manager of sales for the past four years, and a director of the corporation, has severed his connection with the company, effective February 1st. Mr. Blake has obtained the controlling interest in the Canadian Tap & Die Company, Ltd., Galt, Ontario, Canada, of which he has been treasurer since its organization in 1905. He leaves within a few weeks to take the active management of the company's affairs and will devote his entire time to promoting its business. He has a wide acquaintance in the machinery and tool trade and among the hardware jobbers; and his many friends, while regretting his departure from among them, will wish him a full measure of success in his new field.

LINDE AIR PRODUCTS CO.—This company of Buffalo, N. Y., has recently increased its capital from $500,000 to $1,000,000. The company has purchased sites at South Elizabeth, N. J., and North Trafford, Pa., and is proceeding at once with the erection of two large factories. It is anticipated that these two new plans will be completed and in operation by June of this year. The contracts for the buildings have been let as well as for such equipment as the company do not themselves construct in their Buffalo shops. The Linde Air Products Company already have two plants in operation—one in Buffalo and one in East Chicago—but the demand for compressed oxygen and apparatus for oxy-acetylene welding has developed during the past twelve months with such unprecedented rapidity that these additional oxygen plants are required to enable the company to keep pace with the demand.

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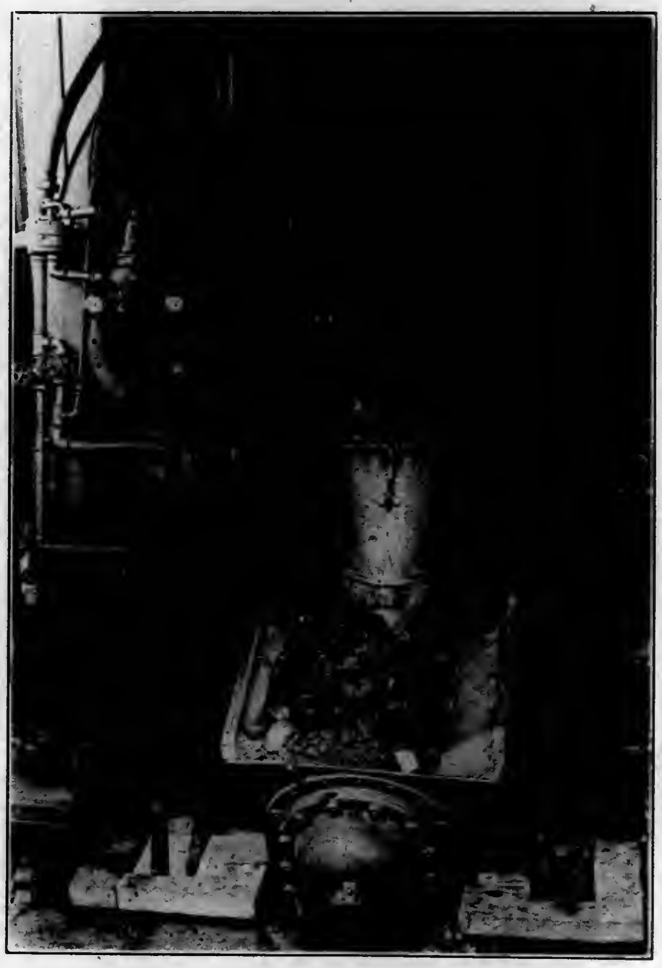
The Hanna Locomotive Stoker

A SUCCESSFUL STOKER OF THE STEAM JET TYPE DESIGNED TO GIVE PERFECT FLEXIBILITY AND CONTROL OF COAL DISTRIBUTION. IT HAS BEEN IN SERVICE FOR NEARLY A YEAR ON A LARGE MALLET COMPOUND LOCOMOTIVE, SUCCESSFULLY DEVELOPING THE CAPACITY OF THE ENGINE WHICH COULD NOT BE REALIZED WITH HAND FIRING.

Locomotive stokers can be divided into three general types, viz., the plunger type, the jet type and the under-feed type. Widely different arrangements of each of these types have been extensively experimented with, most of them with some degree of success. At the present time, however, the examples of the jet and under-feed types appear to be more promising, and of these, three designs stand out very prominently. These are the Crawford, the Street and the Hanna stoker, the first being of the under-feed and the latter two of the steam injection type. All of these have successfully withstood rigorous service tests, and, under the conditions in which they have been operating, can all be regarded as entirely successful.

Though the Street and the Hanna stokers are both of the same general type, they differ in practically all respects. The Street stoker employs a crusher on the tender and chain bucket elevator on the back head of the boiler and feeds the coal through three openings in the back head by means of powerful intermittent steam jets. This stoker will be fully illustrated and described in an early issue of this journal. The Hanna stoker, which is shown in the accompanying illustrations, is a self-contained apparatus and feeds through the fire door.

This stoker has been developed by the Hanna Locomotive Stoker Company of Cincinnati and has been in continuous successful operation on the Cincinnati, New Orleans & Texas Pacific (Queen and Crescent) for considerably over a year, and during the past eight or nine months has been successfully stoking a large Mallet compound locomotive which had proven a failure with hand firing. It has recently been successfully operated on one of the largest Mallet compound locomotives in the world on the Atchison, Topeka & Santa Fe Railway, and is now being applied to a number of locomotives on the Queen and Crescent and to single locomotives on several other railways.



HANNA LOCOMOTIVE STOKER—UPPER COAL HOPPER REMOVED.

This stoker differs in practically all respects from its predecessors of the same general type and is arranged to automatically distribute the coal around the fire box in a regular cycle, being so constructed, however, that if necessary, a large amount of coal can be directed at any one spot desired, or the cycle can be so altered that part of the fire box will continuously receive a greater supply than another part.

As at present constructed, this stoker is built with a hopper holding about 250 lbs. of coal, so located that the fireman can conveniently fill it from the tender. At the bottom of this hopper there is a worm feeder, driven by a bevel gear connection from the small two-cylinder slide valve steam engine self-contained within the machine and located on the deck of the cab close to the boiler head. This worm feeds the coal into an inclined cast iron pipe, through which it is crowded to a discharge in the upper part of the regular fire door opening. The worm in crowding the coal into the pipe crushes it so that there are practically no pieces that will not pass through a 2 in. screen. As it emerges from the top of this pipe it falls down on to a cast iron ridge plate just inside of the door opening, over which there are two inclined wings hinged at the back, and arranged to automatically travel from the top to the bottom of this ridge plate, as will be explained later. These wings form a trough for directing the stream of coal, which then flows down in front of the jets. At this point there is a distinct change from any previous design of stoker, in that there are two sets of jets, the upper emerging from the end of a series of fingers about 3 in. long and arranged in an arc. Directly below these fingers is a very thin, flat opening, from which emerges a thin fan-shaped jet of steam covering practically the whole area of the fire. As the coal flows to these jets the larger pieces strike the fingers and are caught by the jets emerging therefrom and are blown to the part of the fire box served by this particular jet or jets. The finer coal, however, falls between these fingers and is caught by the film jet below. This fine coal is then blown into the fire box with less force and underneath the stronger jets from the fingers, which tend to hold it down on the grate and counteract the effect of the draft while it is in suspension. In this manner only the larger pieces which have sufficient weight of their own to carry them to the grate, are distributed by the upper jets. Below the casting carrying the jets is a table casting which is grooved out on either side in such a form that a certain portion of the coal is carried by means of these grooves into the back corners and underneath the fire door. This table casting is capable of a limited adjustment in and out at will. The steam jets operate continuously and a gauge is provided on each,

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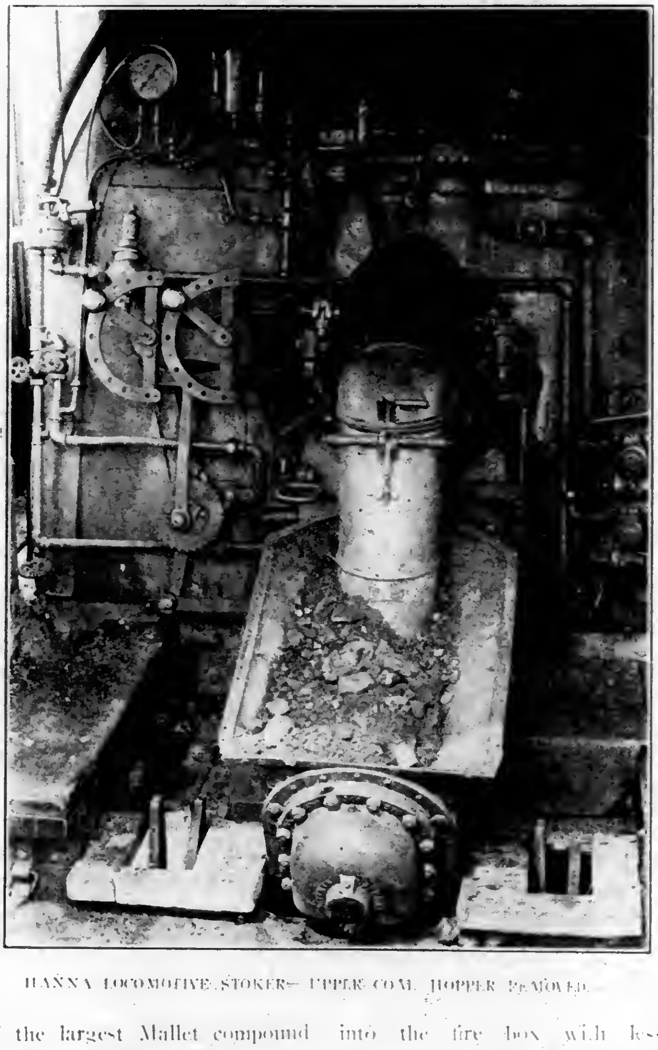


HANNA LOCOMOTIVE STOKER—UPPER COAL HOPPER REMOVED

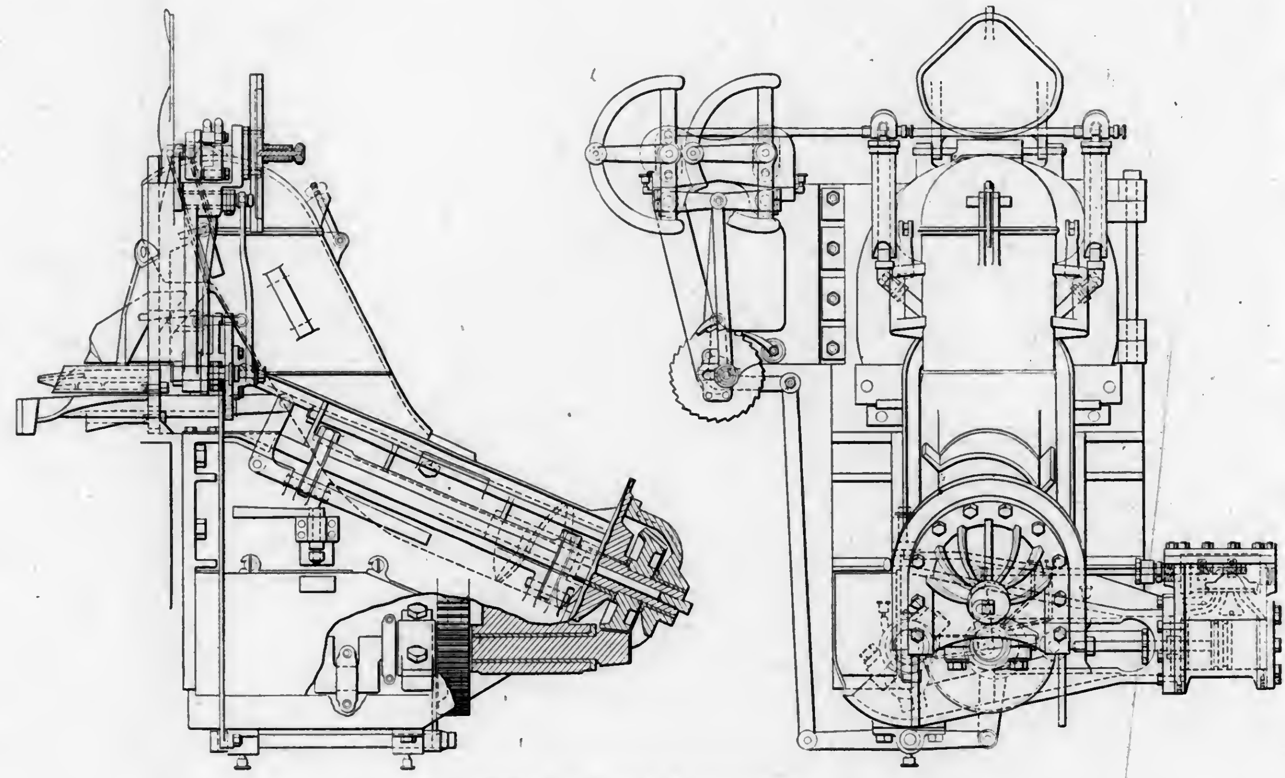
which, in connection with the valve on each line, permits the varying of the pressure as the kind of coal and the condition of the firebox dictates. Normally the upper or finger jets are carried at about 20 lbs. pressure more than the lower or film jet. These pressures will vary between 40 and 60 lbs. and 60 and 80 lbs. under normal conditions.

The automatic operation and independent control of the wings on the ridge plate, which gives the direction that the stream of coal shall take and the point where it shall be discharged on the grate, has been very ingeniously and satisfactorily worked out. Each of the wings are rigidly secured at the back ends to a shaft, which is continued through a universal joint to a point on either side above the inlet pipe. Here are secured short cranks having a ball on the outer end. Over these balls are slipped a spring latch, forming the end of the operating gear coming from its control on the left side. This arrangement gives an easy method of disconnecting if desired.

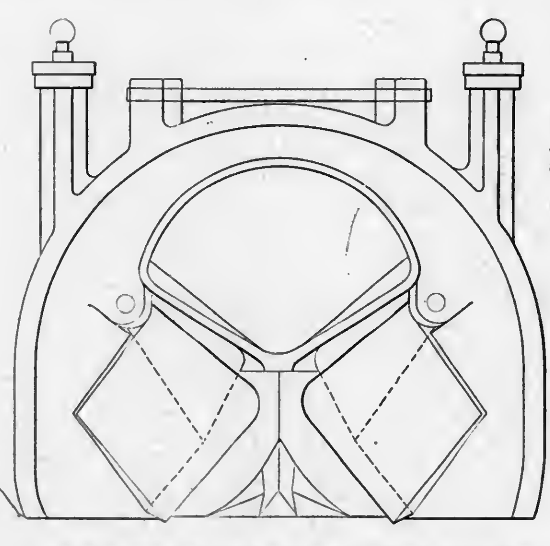
The rods connecting to the operating gear are secured to the top of a slotted block that is hinged at the bottom to a short crank arm operated by the handles on the quadrants shown at the left of the stoker. In the slot in this block is a pin from the vertical arm of a rocker, which is oscillated by an eccentric connection to the ratchet wheel shown just below the quadrants. The throw of this arm is capable of adjustment. The ratchet wheel is operated through a dog on the end of the bell crank connected by a long arm and rocker from an eccentric on the shaft which drives the worm screw.

Since each of the wings in the stoker have a separate connection and gear from the ratchet wheel, it will be seen that either can be adjusted as to its movement by a change in the angularity of the slotted block. If the control lever is so located that the pinned end of the block is at the bottom, the slot will then be vertical in the central position and the wings in the stoker will have their maximum travel. If, however, this operating lever is turned so that the pin connection is at one side, the pin on the rocker will then simply slide back and forth in the slot and the wing casting controlled from this gear will have no movement, remaining stationary in a position at the top or bottom of its stroke, depending upon which way the control lever is swung. Therefore, necessarily any position of the control handles between these two extremes will give either wing a motion from the bottom part way up its stroke or from the top part way down and return in a regular cycle.

A study of this arrangement will show that by throwing both operating levers at the top, for instance, the two wing castings will form a trough in the center and all of the coal will be thrown underneath the flue sheet and on the forward end of the grate. If they are both placed at the bottom of the quadrants the wing castings will remain at the bottom of their stroke and the coal will practically all be discharged into the back corners of the fire box. If one is placed at the top and one at the bottom all of the coal will then be fed along one side of the fire box, being scattered equally. On the other hand, if one is placed at the top of its quadrant and the other is placed to give a full stroke, a cycle of firing will occur through one-



GENERAL ELEVATIONS OF HANNA STOKER.



ARRANGEMENT OF RIDGE PLATE AND WING CASTINGS.

half of the fire box only. From this it will be seen that any possible desired combination for the feeding of the coal can be obtained by the proper adjustment of the control handles. If it is desired to put a large amount of coal in the back corners or underneath the door this is performed by placing both handles at the bottom of the quadrants, shutting off the blast, allowing the coal to pile up on the dead plate and then with a quick blast through the fingers it will be discharged immediately under the door and into the back corners almost entirely.

The two cylinder steam engine operating the stoker is of such a size that in case any foreign substance gets into the worm which would break the machine, the engine will be stalled before this actually occurs. A reversing arrangement is provided with a convenient lever, so that if the engine is stalled it can be immediately backed, and the stone or other obstruction can be removed.

A study of the machine will show that its capacity is governed entirely by the speed of the engine driving the worm. The steam jets will take care of practically all of the coal that can be placed in front of them, and the amount of coal put into the fire box is determined by the amount the worm feed will handle, which in turn, of course, is controlled by its speed. The hopper is set at such a height and in such a position that the fireman can supply a very large amount of fuel with no great difficulty or inconvenience. During a recent trip, when the stoker was delivering to the fire box over 5,000 lbs. of coal per hour, it was found that the fireman, who took things very easily, was actually engaged in shovelling coal less than 40 per cent. of his time. If a capacity is desired which exceeds the fireman's ability to shovel it into the hopper the stoker could be rearranged with the hopper covered by a grating at the deck level, and the fuel put into it by a large hoe, or by gravity.

GENERAL VIEW OF STOKER, SHOWING WORM FEED. COAL HOPPER REMOVED.

On a recent trip of this Mallet locomotive between Somerset, Ky., and Oakdale, Tenn., a distance of 91 miles, over 1¼ per cent. grades, with very sharp curves and many tunnels, the stoker being operated by the observer, who received but the

VIEW SHOWING RIDGE PLATE, WING CASTINGS AND OPERATING GEAR. NOZZLE AND TABLE CASTINGS NOT IN PLACE.

briefest preliminary instruction, it was proven to be all that the inventor claimed for it. The fuel on this trip was very poor quality, being of a character with which it was impossible to successfully hand fire, without numerous stops for fire cleaning, but in spite of this the stoker easily maintained a maximum steam pressure under any and all conditions of work. In fact, it was found possible to open the pops at any time desired, even when the train was on a very heavy grade and the locomotive was working at its maximum power. During the trip, which required eleven hours of elapsed time, the grates were not shaken, there was no hook put into the fire, and at the end of the run the fire bed did not exceed eight inches in thickness and was in every way in perfect condition. Although the locomotive was not equipped with a brick arch at no time when running did the smoke assume a shade darker than light gray. This performance is all the more remarkable, since the stoker in use was a new one and had never been operated on a locomotive before this trip. For periods of thirty minutes or more it was called upon to deliver coal to the fire box at a rate exceeding 5,300 lbs. per hour. While in operation the appearance of the fire box equalled that found in the very best hand firing. It appeared as if a large part of the fine coal burned while in suspension, giving an intense white light, indicating perfect combustion.

ERIE CHANGES LOCATION OF LOCOMOTIVE HEADLIGHTS.—All of the engines of the Erie are to have their headlights changed from in front of the smokestack to the center of the boiler head, where the number of the engine is at present. Engine No. 1704 on the Cincinnati division was the first on that section of the road to have the change made. The position of the headlight will not be altered until the engines are sent to the shops for other repairs, so that it will be some time before all of the engines on the system are changed.

THE EMPLOYEES OF THE YUEH-HAN RAILWAY, CHINA, are organizing a railway club, and with it a library. For this purpose catalogs of all sorts of railway supplies, and more particularly of rolling stock and shop equipment are desired. E. C. Chang, assistant storekeeper of the Yueh-Han Railway, 32 Fung Yuen Ching street, Canton, China, may be addressed.

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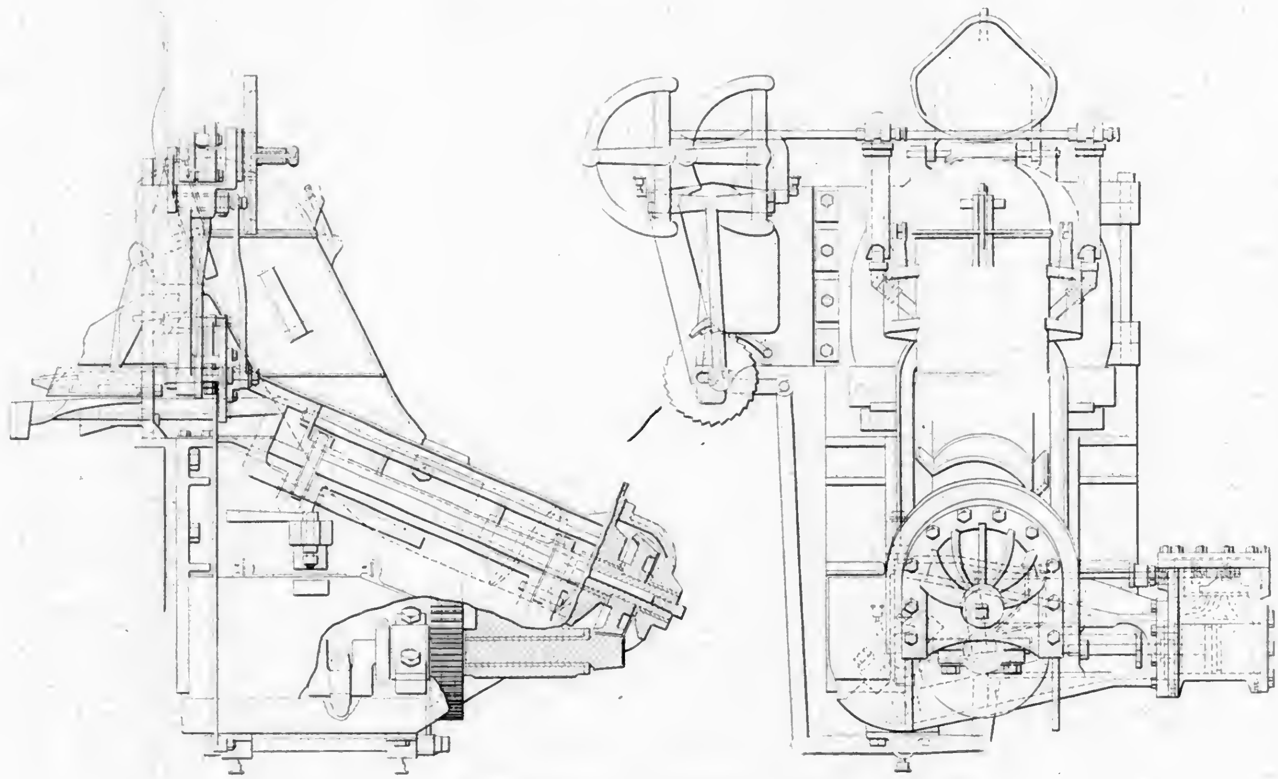


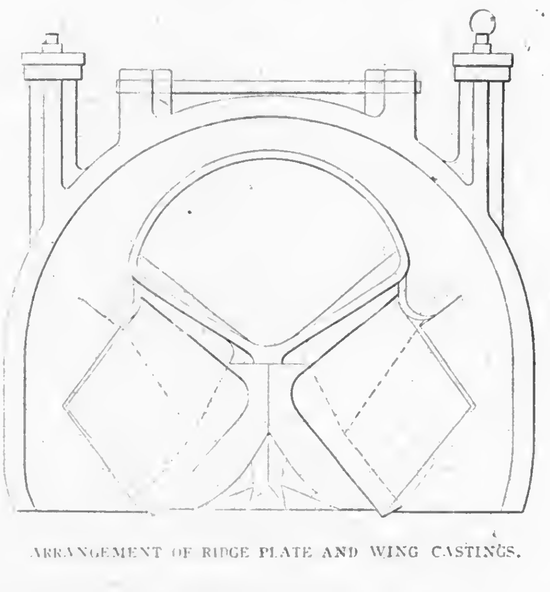
GENERAL ELEVATIONS OF HANNA STOKER.

stream of coal shall take and the point where it shall be discharged on the grate, has been very ingeniously and satisfactorily worked out. Each of the wings are rigidly secured at the back ends to a shaft, which is continued through a universal joint to a point on either side above the inlet pipe. Here are secured short cranks having a ball on the outer end. Over these balls are slipped a spring latch, forming the end of the operating gear coming from its control on the left side. This arrangement gives an easy method of disconnecting if desired.

The rods connecting to the operating gear are secured to the top of a slotted block that is hinged at the bottom to a short crank arm operated by the handles on the quadrants shown at the left of the stoker. In the slot in this block is a pin from the vertical arm of a rocker, which is oscillated by an eccentric connection to the ratchet wheel shown just below the quadrants. The throw of this arm is capable of adjustment. The ratchet wheel is operated through a dog on the end of the bell crank connected by a long arm and rocker from an eccentric on the shaft which drives the worm screw.

Since each of the wings in the stoker have a separate connection and gear from the ratchet wheel, it will be seen that either can be adjusted as to its movement by a change in the angularity of the slotted block. If the control lever is so located that the pinned end of the block is at the bottom, the slot will then be vertical in the central position and the wings in the stoker will have their maximum travel. If, however, this operating lever is turned so that the pin connection is at one side, the pin on the rocker will then simply slide back and forth in the slot and the wing casting controlled from this gear will have no movement, remaining stationary in a position at the top or bottom of its stroke, depending upon which way the control lever is swung. Therefore, necessarily any position of the control handles between these two extremes will give either wing a motion from the bottom part way up its stroke or from the top part way down and return in a regular cycle.

A study of this arrangement will show that by throwing both operating levers at the top, for instance, the two wing castings will form a trough in the center and all of the coal will be thrown underneath the flue sheet and on the forward end of the grate. If they are both placed at the bottom of the quadrants the wing castings will remain at the bottom of their stroke and the coal will practically all be discharged into the back corners of the fire box. If one is placed at the top and one at the bottom all of the coal will then be fed along one side of the fire box, being scattered equally. On the other hand, if one is placed at the top of its quadrant and the other is placed to give a full stroke, a cycle of firing will occur through one

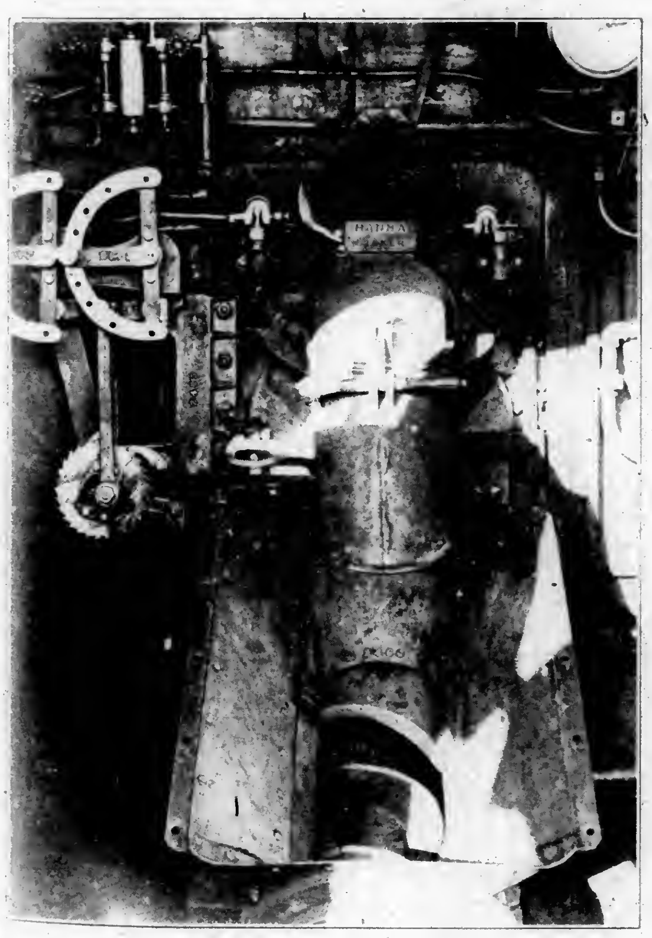


ARRANGEMENT OF RIDGE PLATE AND WING CASTINGS.

of the fire box only. From this it will be seen that any ...ole desired combination for the feeding of the coal can ...ained by the proper adjustment of the control handles. ...is desired to put a large amount of coal in the back ...rs or underneath the door this is performed by placing ...andles at the bottom of the quadrants, shutting off the ... allowing the coal to pile up on the dead plate and then ... quick blast through the fingers it will be discharged ...diately under the door and into the back corners almost ...ly.

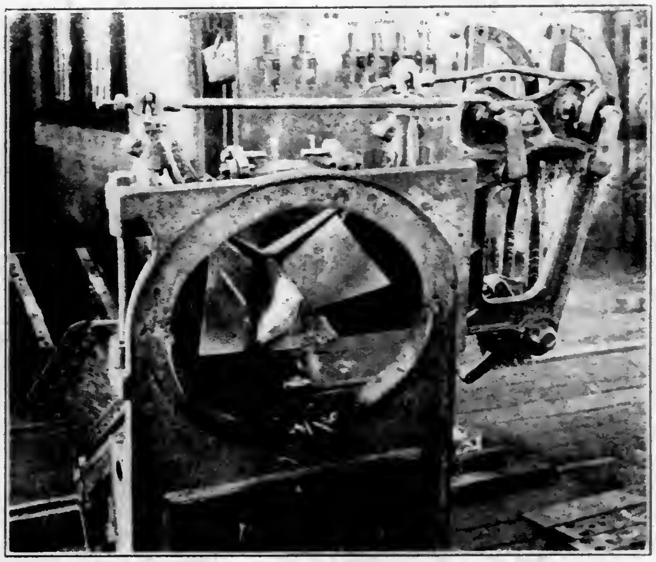
...two cylinder steam engine operating the stoker is of ... size that in case any foreign substance gets into the ... which would break the machine, the engine will be stalled ... this actually occurs. A reversing arrangement is pro... with a convenient lever, so that if the engine is stalled it ... immediately backed, and the stone or other obstruction ... removed.

...tudy of the machine will show that its capacity is gov... entirely by the speed of the engine driving the worm. ...steam jets will take care of practically all of the coal ...an be placed in front of them, and the amount of coal ... to the fire box is determined by the amount the worm feed ...andle, which in turn, of course, is controlled by its speed. ...hopper is set at such a height and in such a position that ...reman can supply a very large amount of fuel with no ... difficulty or inconvenience. During a recent trip, when ...stoker was delivering to the fire box over 5,000 lbs. of coal ...our, it was found that the fireman, who took things very ...y, was actually engaged in shovelling coal less than 40 per ...of his time. If a capacity is desired which exceeds the ...an's ability to shovel it into the hopper the stoker could ... arranged with the hopper covered by a grating at the deck ... and the fuel put into it by a large hoe, or by gravity.



GENERAL VIEW OF STOKER, SHOWING WORM FEED. COAL HOPPER REMOVED.

On a recent trip of this Mallet locomotive between Somerset, Ky., and Oakdale, Tenn., a distance of 91 miles, over 1¼ per cent. grades, with very sharp curves and many tunnels, the stoker being operated by the observer, who received but the



VIEW SHOWING RIDGE PLATE, WING CASTINGS AND OPERATING GEAR. NOZZLE AND TABLE CASTINGS NOT IN PLACE.

briefest preliminary instruction, it was proven to be all that the inventor claimed for it. The fuel on this trip was very poor quality, being of a character with which it was impossible to successfully hand fire, without numerous stops for fire cleaning, but in spite of this the stoker easily maintained a maximum steam pressure under any and all conditions of work. In fact, it was found possible to open the pops at any time desired, even when the train was on a very heavy grade and the locomotive was working at its maximum power. During the trip, which required eleven hours of elapsed time, the grates were not shaken, there was no hook put into the fire, and at the end of the run the fire bed did not exceed eight inches in thickness and was in every way in perfect condition. Although the locomotive was not equipped with a brick arch at no time when running did the smoke assume a shade darker than light gray. This performance is all the more remarkable, since the stoker in use was a new one and had never been operated on a locomotive before this trip. For periods of thirty minutes or more it was called upon to deliver coal to the fire box at a rate exceeding 5,300 lbs. per hour. While in operation the appearance of the fire box equalled that found in the very best hand firing. It appeared as if a large part of the fine coal burned while in suspension, giving an intense white light, indicating perfect combustion.

Erie Changes Location of Locomotive Headlights.—All of the engines of the Erie are to have their headlights changed from in front of the smokestack to the center of the boiler head, where the number of the engine is at present. Engine No. 1704 on the Cincinnati division was the first on that section of the road to have the change made. The position of the headlight will not be altered until the engines are sent to the shops for other repairs, so that it will be some time before all of the engines on the system are changed.

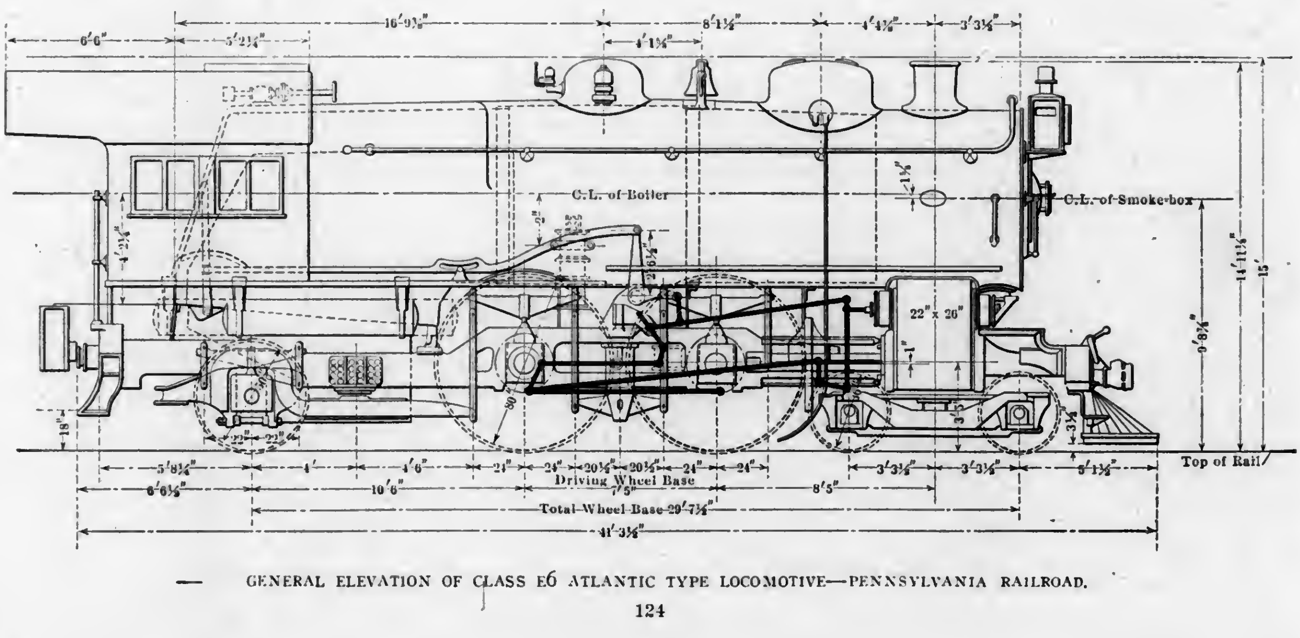
The Employees of the Yueh-Han Railway, China, are organizing a railway club, and with it a library. For this purpose catalogs of all sorts of railway supplies, and more particularly of rolling stock and shop equipment are desired. E. C. Chang, assistant storekeeper of the Yueh-Han Railway, 32 Fung Yuen Ching street, Canton, China, may be addressed.

Pennsylvania Atlantic Type Locomotive Class E6

THE MOST POWERFUL ATLANTIC TYPE LOCOMOTIVE EVER BUILT HAS RECENTLY BEEN TURNED OUT OF THE JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD, AND HAS GIVEN AN EXCELLENT ACCOUNT OF ITSELF WITH HEAVY HIGH SPEED TRAINS ON THE MIDDLE DIVISION OF THAT ROAD, BETWEEN ALTOONA AND HARRISBURG.

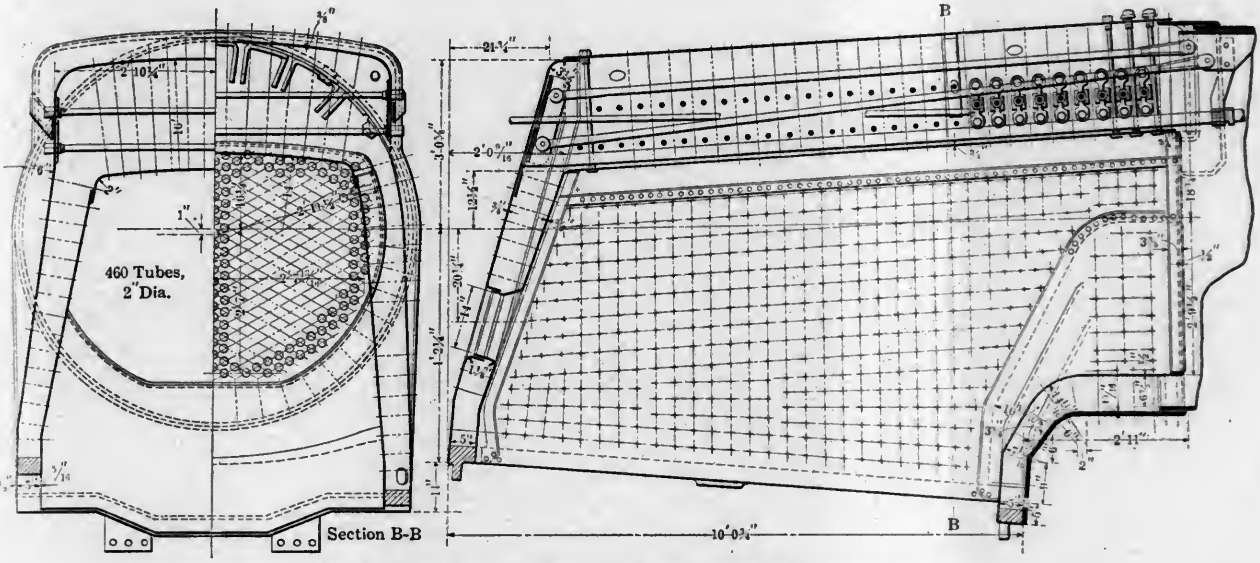
An Atlantic type locomotive with 133,300 lbs. on drivers and a total weight of 231,500 lbs. is the latest product of the mechanical engineer's office of the Pennsylvania Railroad at Altoona. The class E3d locomotive, an Atlantic type, with 80 in. drivers, 22 by 26 in. cylinders, 14 in. piston valves, and Walschaert valve gear, having a total heating surface of 2,640 sq. ft. and weighing 188,600 lbs. has been the standard passenger engine of the lines east of Pittsburgh for a number of years. These locomotives, of which there are a large number in service, up to a comparatively recent date have been thoroughly satisfactory in every way for high speed service of all kinds. The general introduction of all-steel passenger equipment, together with the opening of the new terminal in New York City, which resulted in considerable increase in passenger traffic, has increased the weight of the trains to such an extent that the E3d engines were found to be without any reserve capacity for emergencies and the new class of K2 Pacific type engines have been used on a number of the heavier trains. A careful study of the situation, however, showed that the Atlantic type engine was satisfactory in every way with the exception of an insufficiency of boiler power and therefore a new design has been brought out which is practically a duplicate of the E3d except the boiler, which has been very greatly enlarged. The first engine of this new E6 type was turned out of the Juniata shops on December 22, 1910, and road service since that time has checked the correctness of the original deductions and the engine has been found to possess large reserve capacity in service on the most severe schedules, being able to often make up a surpris-

NEW CLASS OF ATLANTIC TYPE LOCOMOTIVE FOR THE PENNSYLVANIA RAILROAD.

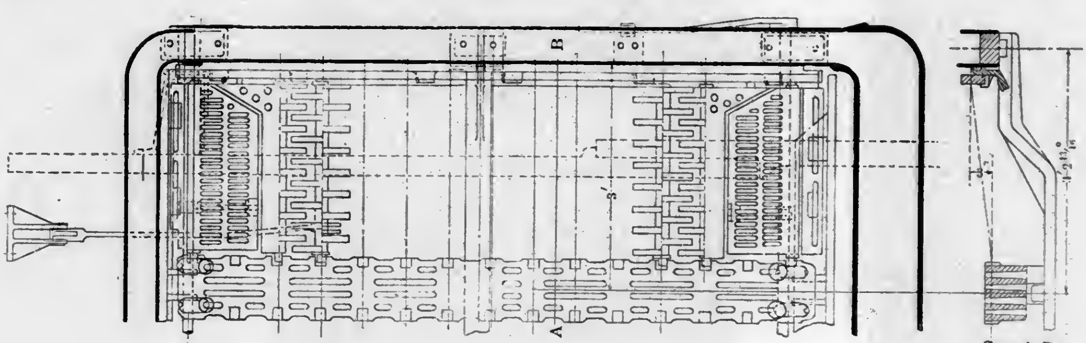


GENERAL ELEVATION OF CLASS E6 ATLANTIC TYPE LOCOMOTIVE—PENNSYLVANIA RAILROAD.

ingly large amount of time over the division. A careful study of the general dimensions and ratios given in the table at the end of this article will show that from all accepted standards this design is by far the most powerful of its type ever designed. If it is assumed that a pound pull at the draw bar can be obtained for 4 lbs. of water evaporated from and at 212 degs. in the boiler, this being a reasonable consumption at 40 miles per hour, with a 30 per cent. cut-off, and it is further assumed that the boiler will give an equivalent evaporation of 14 lbs. of water per square foot of heating surface per hour, it will be found that the locomotive will deliver over 12,500 lbs. draw bar pull at this speed, or practically 35 per cent. more than the E3d under the same conditions.



FIREBOX WITH COMBUSTION CHAMBER—CLASS E6 LOCOMOTIVES.



ARRANGEMENT OF GRATES ON NEW ATLANTIC TYPE LOCOMOTIVE.

A weight of 68,770 lbs. on one axle, as is found on the main drivers of this locomotive, far exceeds the record in this respect not only in this country, but probably in the world. This is carried on 9½ x 13 in. journals, giving a pressure of over 556 lbs. per square inch bearing area. The actual service of the locomotive on the road, however, has shown that this is not outside of good practice, and there have been no hot bearings or pins on the engine during its three months' most difficult experience.

As above mentioned, the running gear is, with the exception of the trailer truck, a practical duplication of the class E3d, and the boiler is very similar in arrangement and capacity to the class H8b consolidation locomotive.* It is of the Belpaire wide fire box type, 76¾ in. inside diameter at the front ring and contains 460 2-in. tubes, which are 13 ft. 11⅝ in. in length. These are somewhat shorter tubes than were used on the H8 and a combustion chamber has been incorporated. One of the illustrations shows the firebox with this combustion chamber and it will be noticed that the inside throat sheet is flanged to form the bottom of the combustion chamber, thus eliminating a very troublesome joint. It will be seen that the sheet is flanged

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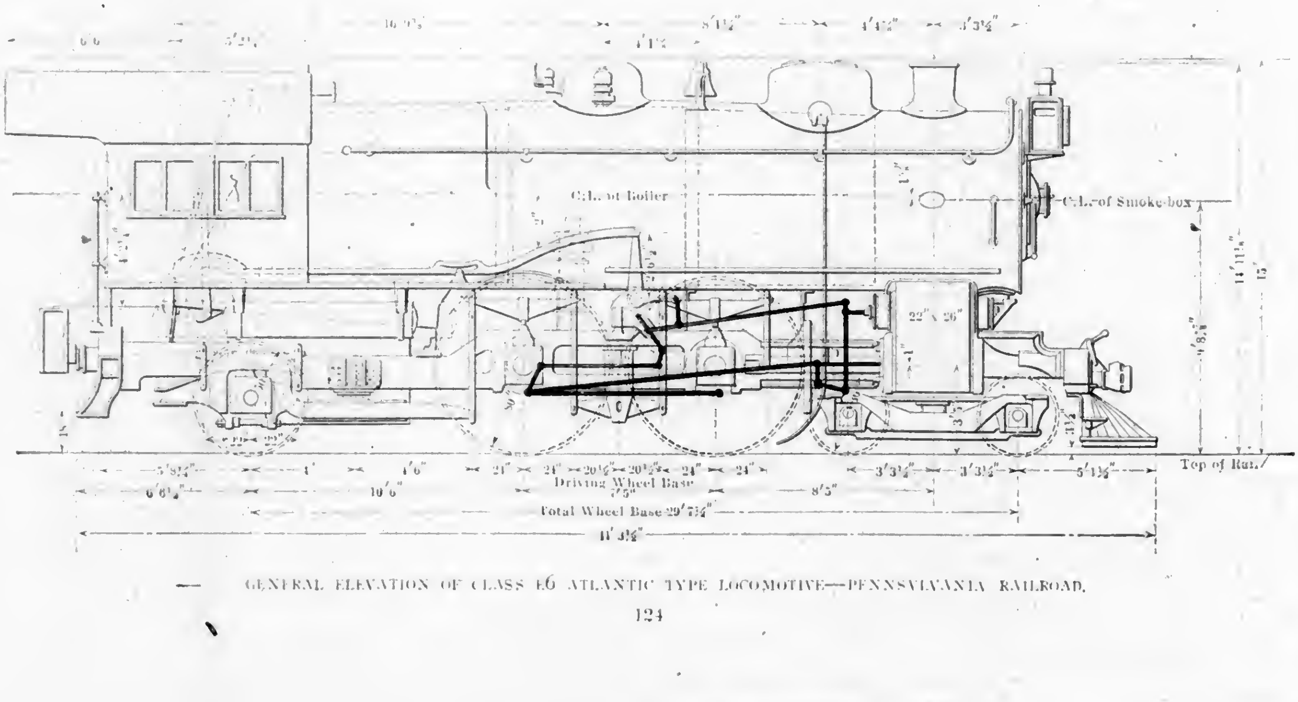

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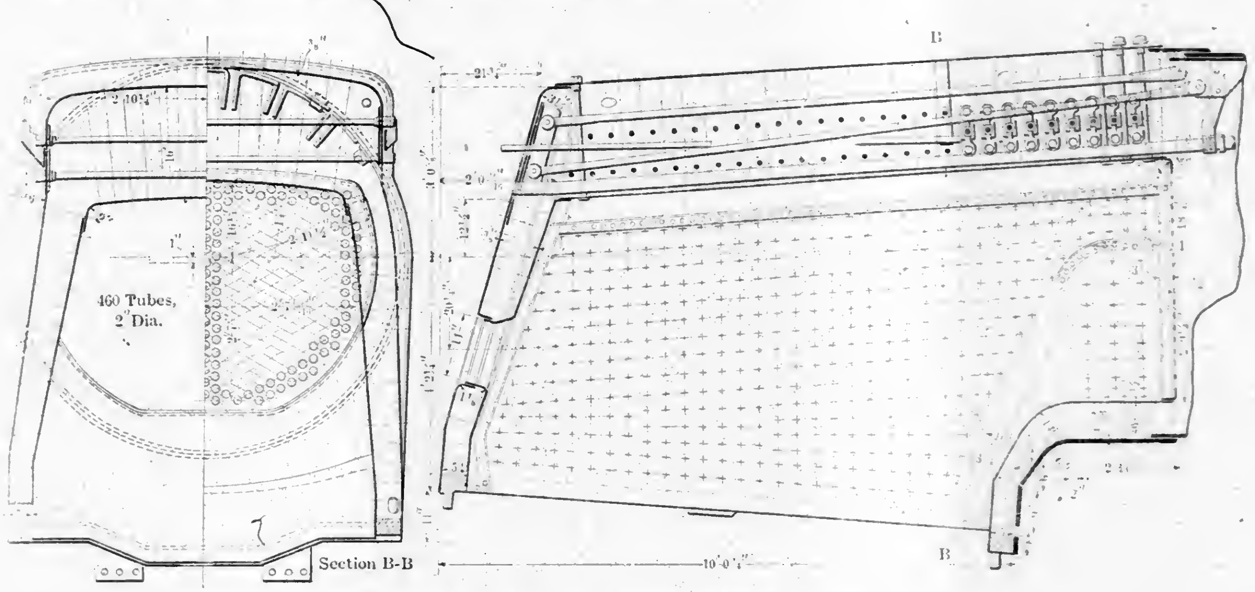

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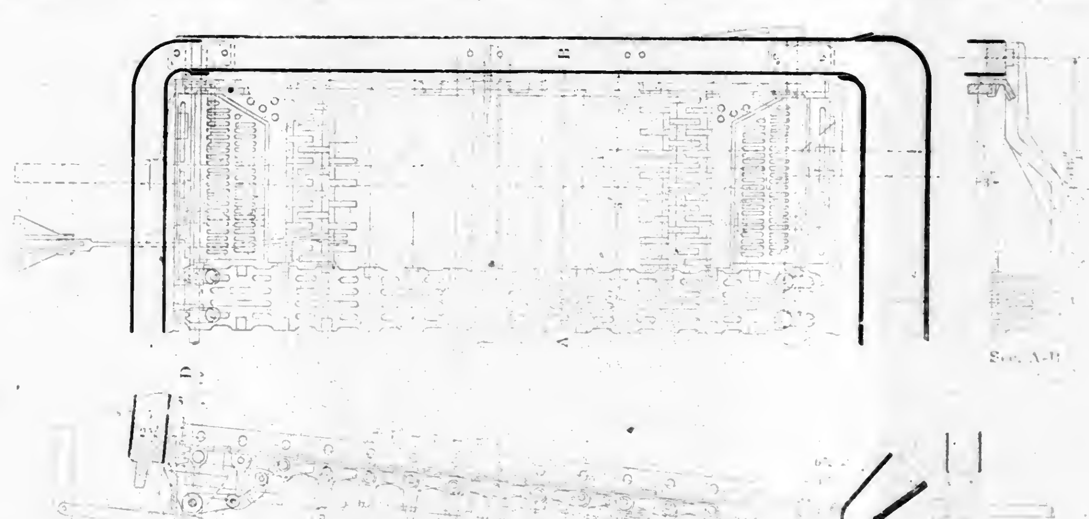

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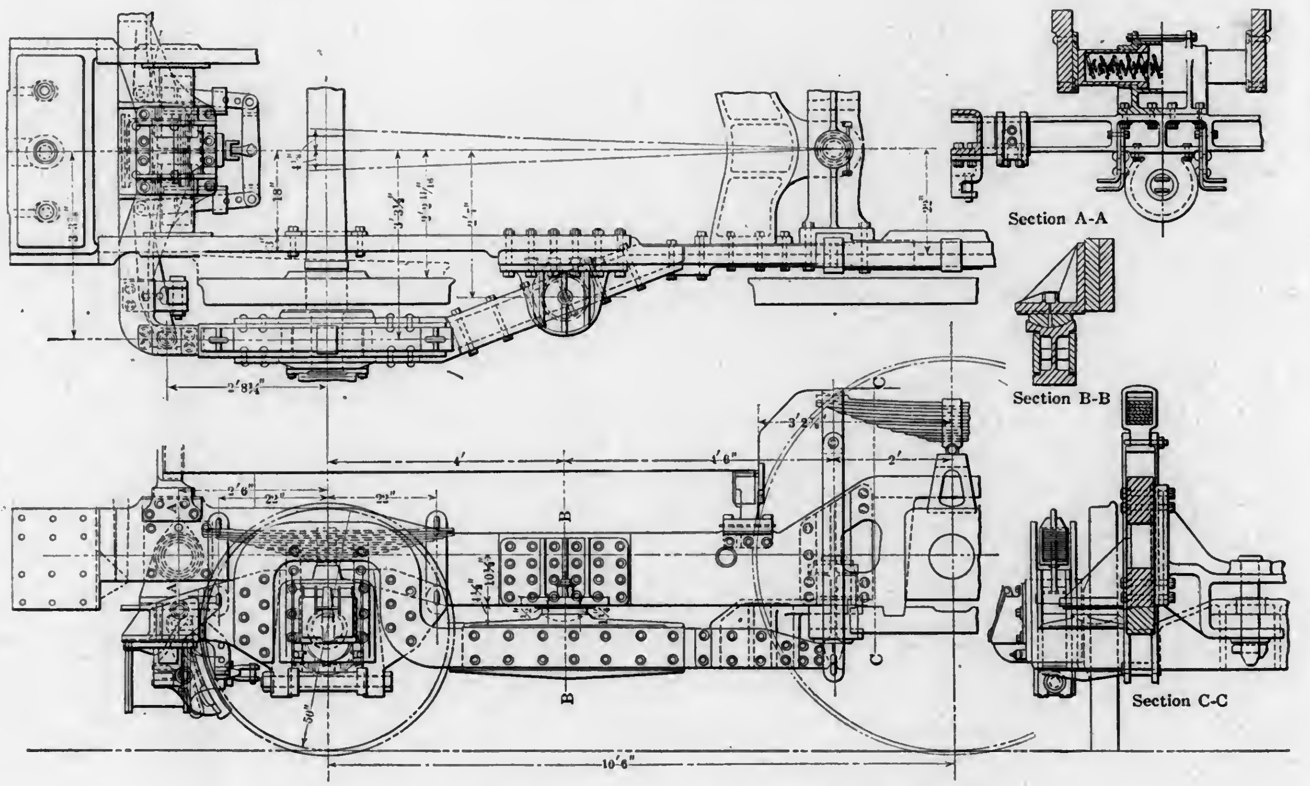
at a large radius and that ample water space has been left around the circular section. Although the sides of the mud ring are straight the rest of the firebox narrows down toward the back in the same manner as does the H8 boiler. The total heating surface is 3,582 sq. ft. as compared with 3,839 sq. ft. in the H8, the reduction being due to the shorter flues, and 2,640 sq. ft. in the E3d. This gives 314 sq. ft. of heating surface to one cubic foot of cylinder volume and 1,312.09 sq. ft. of heating surface to the weight of one cylinder full of steam. The grate area of 55.13 sq. ft. is the same as on the H8, and slightly smaller than on the E3d, and has a ratio of practically 1 to 65 with the heating surface. This ratio was 47.52 on the E3d, indicating that a higher rate of combustion is to be obtained on the new engine. If, as has been assumed above, an equivalent evaporation of 14 lbs. of water per sq. ft. of heating surface per hour is to be attained it will be necessary to burn over 6,000 lbs. of coal per hour or practically 110 lbs. per square foot per hour. While, of course, a fireman is able to deliver coal at this rate for a short time, it is probable that one fireman will not be able to develop the full capacity of the locomotive continuously and as a matter of fact the service for which it is designed will not require the full capacity continuously.



NEW DESIGN OF TRAILER TRUCK APPLIED TO THE CLASS E6 LOCOMOTIVES.

Reference to the illustration will show the arrangement of the grates, wherein a very wide dead grate is used in the center and four drop grates of liberal area are provided. All of the grates on either side are arranged to shake from one connector.

An entirely new design of trailer truck with outside journals, which has many features of interest, has been incorporated in this design. The frame and equalizers have been combined and the weight is transferred through a combination semi-spherical and sliding bearing placed between the engine frame and the trailer frame or equalizer. Provision is made at the pivot pin for 3 in. vertical movement in either direction. A substantial spring centering device is incorporated, arranged as shown in the illustration, and the brake cylinder for the trailer truck brakes is also carried at the rear of the trailer frame. It will be noticed that a grease cup is provided above the bearing point, so arranged as to keep both the flat and the spherical surfaces properly lubricated. An inspection of the illustration will show the details of this arrangement.

Although the main frames in general are from 4 to 4½ in. in width, and 6⅜ in. in depth on the upper rail, at the driving pedestals they have been widened out on the inside to 7⅞ in. in width and narrowed in depth to 4⅜ in. An unusually substantial connection between the front and main frames is evident from the drawing showing the frame details. A study of this drawing will show that the utmost care has been used to provide proper strength at the points subjected to the greatest stresses and at the same time to make the whole construction as light and flexible as possible. The pedestal braces are most substantial and are secured by two bolts at either end.

The Walschaert valve gear used is the same as has been previously applied to the class E engine.*

The general dimensions, weights and ratios of the locomotive are given in the following table:

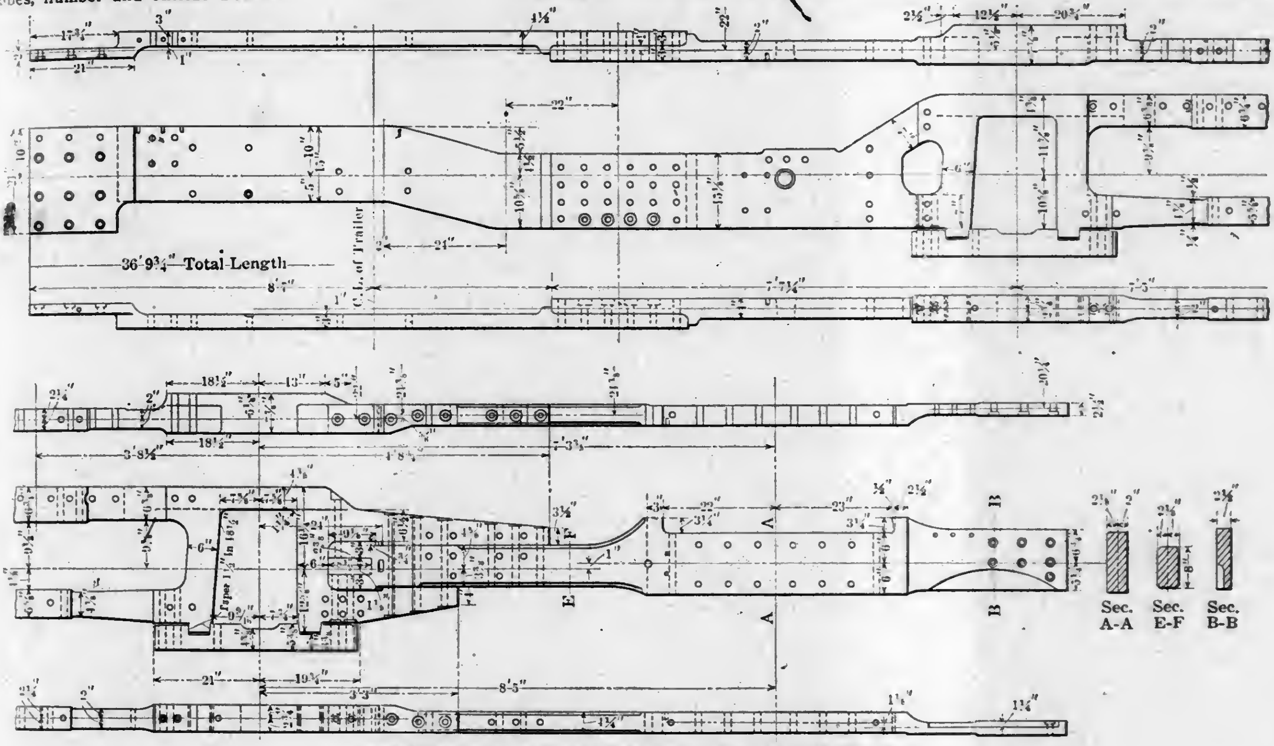
GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Bit. Coal
Tractive effort	25,797 lbs.
Weight in working order	231,500 lbs.
Weight on drivers	133,300 lbs.
Weight on leading truck	51,270 lbs.
Weight on trailing truck	46,930 lbs.
Weight of engine and tender in working order	389,500 lbs.
Wheel base, driving	7 ft. 5 in.
Wheel base, total	29 ft. 7½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	5.18
Total weight ÷ tractive effort	8.97
Tractive effort × diam. drivers ÷ heating surface	578.00
Total heating surface ÷ grate area	64.97
Firebox heating surface ÷ total heating surface, per cent	6.10
Weight on drivers ÷ total heating surface	37.10
Total weight ÷ total heating surface	64.60
Volume both cylinders, cu. ft.	11.40
Total heating surface ÷ vol. cylinders	314.00
Grate area ÷ vol. cylinders	4.85
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 26
VALVES.	
Kind	Piston
Diameter	14 in.
Greatest travel	7 in.
Outside lap	1 5/16 in.
WHEELS.	
Driving, diameter over tires	80 in.

* See American Engineer, July, 1908, page 253.

Driving journals, main, diameter and length . . . . . 9½ x 13 in.
Engine truck wheels, diameter . . . . . 36 in.
Engine truck, journals . . . . . 5½ x 10 in.
Trailing truck wheels, diameter . . . . . 50 in.
Trailing truck, journals . . . . . 6½ x 12 in.

BOILER.

Style . . . . . Belpair
Working pressure . . . . . 205 lbs.
Inside diameter of first ring . . . . . 76¾ in.
Firebox, length and width . . . . . 72 x 110¼ in.
Firebox plates, thickness . . . . . ⅜ & ½ in.
Firebox, water space . . . . . 5 in.
Tubes, number and outside diameter . . . . . 460—2 in.



THREE SECTION FRAMES USED ON CLASS E6 LOCOMOTIVES.

Tubes, length . . . . . 13 ft. 11⅝ in.
Heating surface, tubes . . . . . 3,364 sq. ft.
Heating surface, firebox . . . . . 218 sq. ft.
Heating surface, total . . . . . 3,582 sq. ft.
Grate area . . . . . 55.13 sq. ft.
Smokestack, height above rail . . . . . 14 ft. 11⅛ in.
Center of boiler above rail . . . . . 9 ft. 8⅞ in.

TENDER.

Wheels, diameter . . . . . 36 in.
Journals, diameter and length . . . . . 5½ x 10 in.

TWENTY-FIFTH YEAR OF THE RAILWAY CONGRESS

The International Railway Congress Association was established in 1885, and Mr. Weissenbruch, general secretary, prints in the *Bulletin* for January a historical review of its work during the quarter century. At the first session (in Brussels in 1885) the Congress represented 19 governments, 131 railway systems and 31,000 miles; and the number of delegates present was 289. At the eighth session, in Berne, Switzerland, last year, the number of governments represented was 48, railway systems 420, and mileage of railways 359,858; and the number of delegates present was 799. An abstract of the principal topics which have been discussed by the Congress and the conclusions thereon fills 100 pages of the *Bulletin*. As to the function and usefulness of the association, Mr. Weissenbruch says:

It has been said in the daily press that the conclusions adopted at the general meetings have too often been general expressions in which the general public would vainly look for definite and precise solutions. These conclusions are necessary for starting the discussions, but they must be drafted in such a way as to make it possible for them to be adopted without too much opposition at the general meetings where the delegates who have specially studied them are relatively few in number. Every step in advance is in its origin the work of a minority; it must raise some doubts in a meeting where the majority has not yet recognized its necessity. But what does it matter? At the same time while the meeting formulates its impersonal opinion, each of the managers of engineers present at the meeting forms or modifies his personal opinion. His attention is drawn to the question. When he reaches home, he studies it again. He is much assisted both by the documents he brings home with him as well as by the relations of friendship or of mutual esteem which he has formed at the periodical meetings of the Congress. It is thus by no means one of the least results of the Congress Association that it forms, for railway men, a stimulus which takes them away from their daily routine. How much useful work may thus result from intelligent and better directed zeal!

RAILROADS' GROSS EARNINGS FOR 1910

The gross earnings of the United States railroads for the calendar year 1910 amounted to $2,825,246,281, an increase of $229,490,446, or 8.84 per cent., as compared with the preceding year. Commenting on this showing the *Chronicle* says:

"Unfortunately the gain in gross earnings, notwithstanding its magnitude, hardly sufficed to meet the rise in operating cost and the resulting enormous augmentation in expenses. It was this latter feature that furnished such grave cause for apprehension and induced the vigorous efforts on the part of railroad officials to raise rates—efforts which the recent decision have now settled. The principal item in the augmentation in expenses was the advances in wages which the carriers were obliged to make in practically all grades of the railroad service. It is testimony to the way in which expenses have been mounting up that this great gain in gross receipts should have been practically wiped out, and none of it saved for the net, and perhaps more than wiped out, because as yet it is not possible to state whether the total of the net will show a trifling increase or actually record a loss."

Following is a summary of the gross earnings from January 1 to December 31 for a series of years:

Year.	Gross Earnings.	Increase.	
1894	$1,046,616,407	*$130,205,328	11.07%
1895	1,086,464,608	62,202,827	6.05%
1896	1,114,430,883	206,004	0.02%
1897	1,185,154,654	62,337,075	5.55%
1898	1,253,807,714	81,030,578	6.98%
1899	1,332,666,853	118,980,243	9.81%
1900	1,459,173,305	113,972,300	8.46%
1901	1,603,911,087	148,988,902	10.24%
1902	1,705,497,253	100,863,714	6.28%
1903	1,918,652,252	202,193,361	11.77%
1904	1,966,596,578	8,765,279	0.45%
1905	2,099,381,086	169,998,137	8.76%
1906	2,374,196,410	241,913,596	11.34%
1907	2,595,531,672	221,642,861	9.33%
1908	2,235,164,873	*301,749,724	11.90%
1909	2,595,466,402	278,038,372	11.65%
1910	2,825,246,281	229,490,446	8.84%

* Decrease.

DIRECTORS OF THE NEW HAVEN have approved plans for a new stone and brick station in New Haven that will cost $1,000,000. It will be 1,000 feet long and about 500 feet wide, and is to be completed one year hence.

Development in Tool-Room Methods

A REVIEW OF WHAT HAS BEEN BROUGHT ABOUT IN CORRECTING THE STANDING ABUSES OF THE RECENT PAST, AND A COMPARISON BETWEEN THE IDEAL CONDITIONS OF THE PRESENT, IN THE LINE OF IMPROVED FACILITIES, AND THE PERIOD WHEN FEW TOOL ROOMS EXISTED, AND LITTLE, IF ANY, SYSTEM WAS IN EVIDENCE.

The fact is now generally recognized that proper and economical work depends upon the tools used, the condition in which they are kept, and their availability for service, when needed. It may be safely asserted, in fact, that these three requisites constitute the sole requirements, with the possible exception of efficient labor, and this latter need scarcely be reckoned with seriously, as experience has shown that it will logically follow when ideal tool or shop conditions become in order.

A careful and unbiased review of what has been accomplished through various efficiency schemes, so called, points conclusively to the fact that whatever good results may have been attained are due as much to improved shop and tool conditions as to any other features pertaining to these systems. Inquiry along these lines would lead to the inference that a complete metamorphosis in ancient and wasteful methods, such as was necessitated as a preliminary to the advent of any system, practically turned the trick. In other words, the vastly better facilities provided served the purpose far more to the point than the methods of doing work, time studies, etc., which constitute the system proper, although the latter, or the idea embodied, invariably receives all of the credit.

It is no doubt fully appreciated without this comment that up to about fifteen years ago little, if any, system of looking after tools prevailed anywhere. Few locomotive terminals provided the semblance of a tool room. The wrenches, jacks and even the special devices were scattered promiscuously about the roundhouses, and many of the former, which through necessity should have been common property, such as steam pipe wrenches, and even spring pullers, were actually locked up in the cupboards of the machinists who happened to see them first. It is recalled in this connection that on the occasion of a search through a prominent Eastern roundhouse, simply to test the situation, during the period referred to, failed to reveal a single wrench, even including the commonest sizes of those days, seven-eighths, inch, and inch and one-eighth. What jacks were visible had galled threads, and jack levers were absolutely at a discount.

The effect of such a situation on a new man coming to work, or an apprentice just out of his time in such a shop, could not be other than most depressing. His usefulness was practically nil until he had been there long enough, generally five or six months, to beg, borrow or steal, as a rule the latter, a sufficient number of working wrenches. Beyond furnishing him with a machinist's kit, *i. e.*, a hammer, large and small monkey wrenches, and a flat and a cape chisel, the various companies did absolutely nothing to help him out. Files, of course, could be drawn from the storeroom, as could emery and emery cloth, and occasionally a soft hammer, but this was all; and there were many other things necessary for the simplest operations in running repairs. Among the number actually required were open-ended wrenches, three-quarters, seven-eighths, inch, and inch and one-eighth, also socket wrenches of the same sizes. To secure these devious ways and means were resorted to.

In those happy-go-lucky days almost every engine had a good set of tools in the right hand seat box, laboriously collected by the engineer who practically owned the same engine for years. The most common resort was to break this box open at a favorable moment and abstract from the contents what was required. Sometimes, but very seldom, an obliging blacksmith would make a wrench or so for the new machinist, and a master mechanic has been known to write an order on the blacksmith for a set. Besides wrenches, there had to be included in the kit a three-quarter inch hexagon steel pin bar, assorted size stud nuts, a rough forged auger-shaped arrangement for grinding check valves, and many other things no need to mention.

It will be thus readily appreciated that it became a source of laborious endeavor to gradually accumulate a set of working tools, and there is much food for thought in speculating on how much money was lost by the company on a man's time while he was engaged in gathering the various items. Still the shop management appeared to absolutely disregard this factor, and it may, perhaps, be well to make some little explanation of its singularly complaisant attitude in the presence of a situation so uneconomical, to say the least.

Familiarity with those days, of say twenty years ago, leads to the conclusion that the indifference of the master mechanics must have arisen from lack of knowledge of the actual conditions, and this in turn may be explained through the fact that organized labor had not yet invaded the railroad field. There was no shop committee to present these things as grievances, which they would be quick to do now, to the shop management, and furthermore, labor of any grade, with the possible exception of the engineers, was not self-assertive. A machinist would not think of telling a master mechanic that he needed tools to work with. If he mentioned it to the foreman he would be told to do what the rest had to do—"hunt for them."

Conditions in the machine shops, at least in the large majority, were equally distressing with those present in the roundhouses. The apprentices, who performed the greater part of the machine work, had to beg the blacksmiths to make their lathe or planer tools. Every tool was zealously guarded during the day, and as carefully locked up at night. To secure additional protection the boys took accurate measurements of the width of their tool post slots, and had their tools made just a mere shade smaller. This insured that they could not be used in a narrower tool post, and so minimized the liability of theft. No one was foolish enough to have his tools made the size of the narrowest tool post, and the unfortunate assigned to the machine carrying the latter usually held the position of general victim for tool despoliation.

If an apology for a tool room existed in such machine shops it had no attendant. It was a shack erected in one corner, and contained a few unlettered or unnumbered rough bins in which taps and reamers were piled in random heaps. Many of the taps were broken so that they could only by the greatest skill and patience be inserted in a hole, and the cutting edges of the reamers were generally in bad shape. Apprentices used to be very hard on hand tools; in bottoming taps, reaming, or trying to ream one-eighth inch, etc., and if anything broke it was easy enough to throw it in a bin and say nothing about it, there being no check on the action. This invariably applied to ratchets, a very common tool of the period where everything was hand work. It was simply up to the caliber of the mechanic, whether he broke it and left it in a roundhouse pit, or repaired and returned it.

This might be prolonged indefinitely, but enough has been said to illustrate the point. Some of it may seem exaggerated, but on the contrary it is far from being exploited in its full gravity. It is not intended to say, of course, that what has been commented upon is representative of the general situation, but many more than one big system can be recalled at this writing which embodied these conditions. Although no greater contrast between the then and now can possibly be imagined, still it is well remembered that the Baltimore and Ohio ran clear up to the receivership in 1896 in just this fashion. This and many

other roads provided no tools for roundhouse men except of the most primitive description, and had no check on those that were provided.

It is believed that two principal factors predominated in contributing toward the increased output, or the increased efficiency, which means practically the same thing of the present contrasted with the past, and these: the advent of some form of compensation for labor, other than day work, and the gradual materialization of organized labor. The first required a preliminary overhauling of the shops to see if the proper appliances existed to handle the various proposed piece or bonus work schedules, thus bringing to light the alarming nature of the tool situation, where possibly it was unknown before, and the second provided the means to keep the management advised by the men themselves of a falling off in any tool standard which may have been established.

The reform in this regard which characterizes the present was not, however, effected in a day. There was much planning and many preliminary maneuvers extending over weeks and even months before even a semblance of one of the now standard systems became established. The first move was to "raid" the machinists' cupboards, which was not effected, by the way, without considerable opposition, but the harvest of wrenches and what not garnered therefrom served as the nucleus of many a future toolroom. Nothing was left but the ordinary working kits, and after the first wrench of parting with their laboriously gathered possessions had passed, the machinists and boilermakers felt pretty good after all, because they realized that so long as their company had assumed this arbitrary action it was up to it to provide for their needs in the tool line thereafter.

That the various companies have done so needs no comment. With their attention called to the abuses which had prevailed, they readily appreciated that in order to facilitate work, system must prevail in the care and distribution of tools, so that excessive numbers of them would not accumulate, and with further refinement, so that expensive tools would not be kept idle in one place when needed in another. System was inaugurated in the standard designs of tools and in methods adopted for doing work, with economy and good work always as the ends in view.

In pursuance of these objects the majority of the railroads unconsciously, almost, gravitated toward the plan of some central supervision for the various tools and operations; some authority to decide on the design of tools, jigs, special devices, etc., and all suggestions as to change in methods, new forms of tools, and what not, to be submitted to and receive the approval of that office before being adopted. This was necessary, of course, as often ideas and methods are developed at considerable expense in one place, when they have been already tried and proved unsatisfactory elsewhere. The plan of community of ideas between shops, to insure which the chief tool inspector, general inspector, or whatever his title may be, is responsible, promptly served to eliminate this useless expense. It was a remarkable transition from the former random period referred to when operations at one division shop were too frequently a sealed book to another maybe only one hundred miles away.

The intelligent handling of this scheme has worked out some truly wonderful results, and has brought improved conditions for shop workmen almost inconceivable when compared with the situation only twenty years ago. It is rare indeed at the present time to hear the old complaint—"Nothing to work with." The men know that the facilities are there and it is simply up to them to make good, whereas heretofore there was always a loophole to retire behind the old excuse and the company could not consistently dispute the justice of the plea.

While the tool regulations differ in minor points between the various roads an exhaustive review of many indicates that the highest ideals and standards are arrived at, and it may be safely said that anyone of them followed as indicated will leave nothing to be desired, from the double standpoint of convenience for the workman and efficiency and increased output for the company.

A review of these various regulations prevailing on different roads would no doubt prove of considerable value, but in the interest of brevity it is thought best to confine to one road; the Atchison, Topeka and Santa Fe, whose tool system, developed from the best practice in use at first-class shops, is quoted below:

1. Perpetual or continuous inventory will be had of all tools, machines and devices of all sorts at each shop, showing location of tool, whether assigned to tool-room stock or to the permanent use of an individual man or gang.

2. Uniform aluminum checks of special design, six to each man, will be furnished from Topeka for each shop, indicating shop and the block number of the mechanic to whom issued; these checks will be issued only to such men as required to call on the tool-room for tools. Topeka will be called on for such checks as are required from time to time, which will be forwarded by railroad mail.

3. Standard tool lockers will be assigned to men using tools, as far as practicable.

4. Standard tool kits, for each class of occupation, will be determined upon, and these kits supplied to the man when he enters the employment, he signing up for them, and being held responsible therefor; the man will also be held responsible for the checks issued.

5. A regular periodical, weekly inspection system of all tools will be inaugurated as rapidly as it can be organized. In addition to these general measures the following special regulations will be in force:

6. No tools issued from tool-room except for tool check.

7. No new hand-hammers or monkey wrenches to be given in exchange for old ones unless accompanied by an order from the gang foreman, and marked "O. K." by the shop foreman; chisels and soft hammers to be the only tools exchanged for news ones without a written order.

8. No letters or figures to be given out in lots of less than a full set.

9. All tools out on check must be turned into the tool room every Saturday night, before the tool keeper leaves the shop. In all cases where tool checks remain on the board over Sunday, the tool keeper should notify the tool-room foreman or the general foreman, and the men whom these checks belong to should be required to give an explanation for not returning the tools. In some shops it may be desirable to check up the tools daily.

10. In all cases of broken, lost or damaged tools, the tool check will not be returned until the tool clearance card has been personally signed by the general foreman as per circular letter.

11. In places where, in addition to tools, the tool-room is used for a sort of shop sub-store for small engine supplies, such as cutters, small bolts, etc., the gang foreman's orders will be honored for these supplies.

12. The custody of all high speed lathe, planer and boring mill tools should come under the tool-room foreman, or the man in charge of the tool-room. A man starting to work on a machine requiring these tools should be given a set, and these should be charged to him. Should he break one of these tools, he will exchange it for a new one in the tool-room. The tool-room foreman or the tool man should get a list of the number of high speed tools, the list showing size and style now at various machines, and the workmen should sign up for them.

13. All air motors must be returned to the tool-room every Saturday night, and be thoroughly inspected and oiled before leaving the tool-room again. At shops like Topeka, Albuquerque, San Bernardino, and Cleburne, it may be desirable to assign certain motors to a gang and that this gang be allowed to use these motors during the week, turning them into the tool-room on Saturday night for regular inspection. All motors should be numbered and a record kept of what gang they have been assigned to. Where parts of motors are missing the motors should not be accepted without authority of the tool-room foreman. It should be the tool-room foreman's duty to see that all motors are regularly inspected and repaired and oiled as often as necessary, which, for motors in service should be as often as once a week.

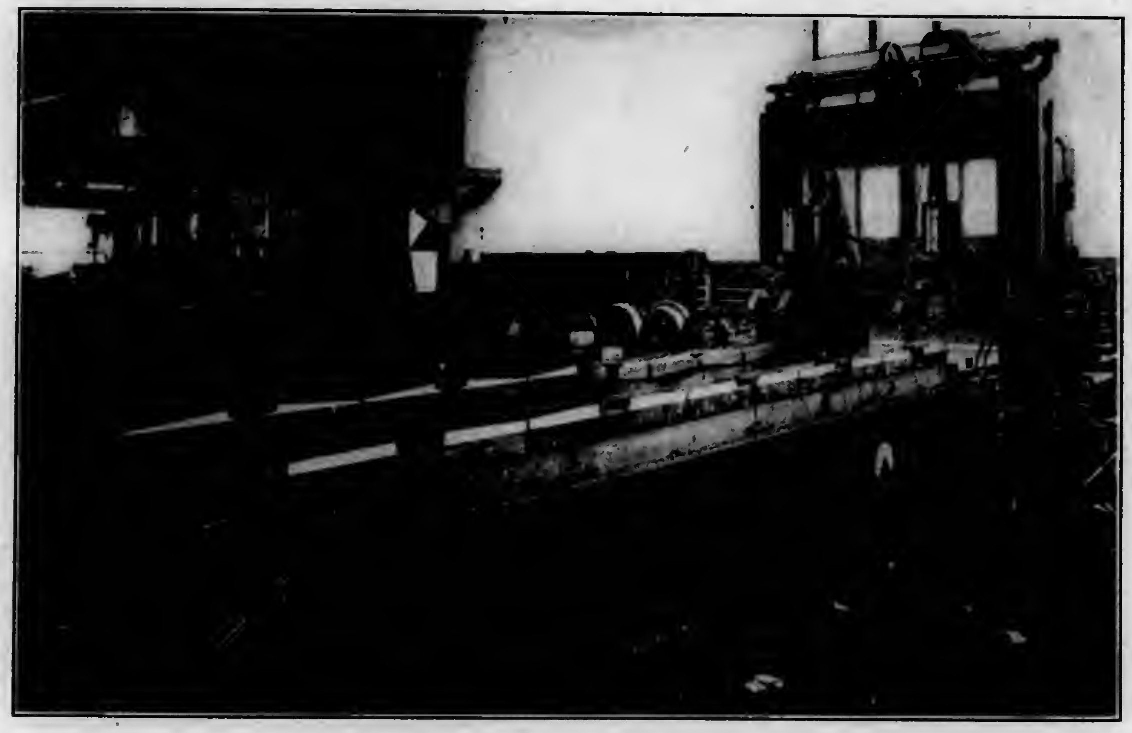
It will be readily appreciated that if the above is adhered to, and there need be no uncertainty on that point, the workman of to-day is enviably situated in comparison with his prototype of yesterday, and unquestionably his employers are better off. So long as the tools are practically put into his hands in the very best condition, the mechanic must perforce work, and a long stride is made at once toward efficiency. On the Santa Fe, in addition to this refinement in tool accounting, standardization of tools and methods has been gone into in great detail, and the Erie Railroad is not far in the rear. The movement is now general to avoid all random methods, and superfluous tools and concentrate on those most efficient, practical and suitable for general use.

Great Elevator for the Grand Trunk.—With its recent completion the Grand Trunk now has at West Fort William the greatest elevator in the world, its capacity being 3,250,000 bushels. It is the first of a unit of six to be built, with a total capacity of 10,000,000 bushels, and which will have three piers. Then it will be possible to unload 2,400 cars a day, and discharge 300,000 bushels per hour into vessels.

DEVICES FOR MACHINING LOCOMOTIVE PARTS

CENTRAL OF GEORGIA RY.*

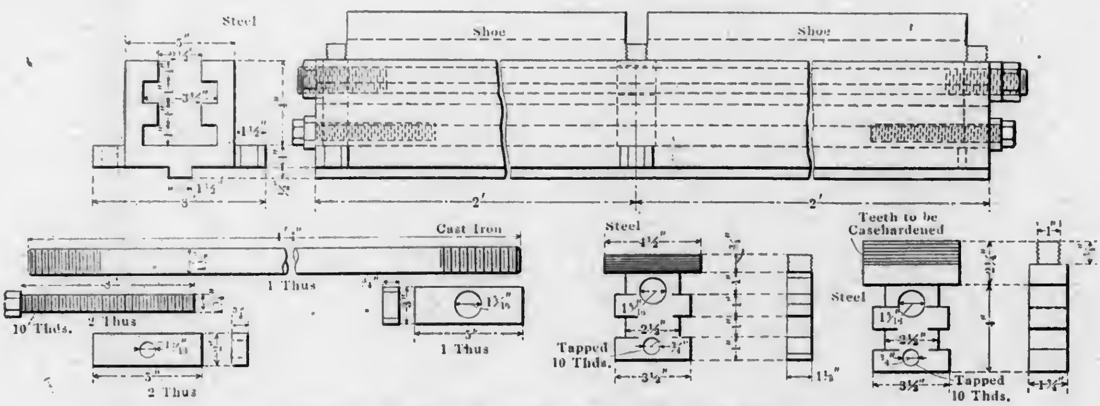
Considerable ingenuity is being displayed on Southern railroads at present in working out improved methods for doing work, and particularly in the line of time and labor saving devices for machine shop work. Some of these latter are remarkably efficacious in serving the purpose for which designed, and a careful study of their details, as shown in the drawings herewith, with a view to adopting them for similar work anywhere, will prove to be time well spent. They point conclusively to the fact that the South is not lacking in its full quota of clever mechanics who are continually on the alert to originate and develop schemes for the betterment of their existing shop facilities and methods.



CHUCK FOR PLANING SHOES AND WEDGES.

The Central of Georgia Ry., some of whose special shop devices have previously been described in this journal, has been well in the vanguard of this progressive movement. Its Macon shop management has perfected and installed a number of homemade appliances which have vastly increased the output, and at the same time have secured a remarkable reduction in the former costs of doing work. Those illustrated in connection with this article are the latest additions to the shop equipment, and have been carefully worked out with the end in view to secure a still further refinement in the results desired. They are in daily service, and are now no unimportant factors in the general efficiency to which the Macon shops have been raised.

A particularly desirable accessory to any locomotive machine department may be found in the chuck for shoes and wedges which is illustrated in half tone and in detail arrangement. It will be noted that this device is very simple, requiring very little time and labor to chuck the shoes or wedges, and it can be used on either a planer or milling machine. The chuck shown in the photograph is made up of several sections, so that it can be used on various lengths of planer beds, although there is nothing to interfere with making it of any length which local conditions may dictate.



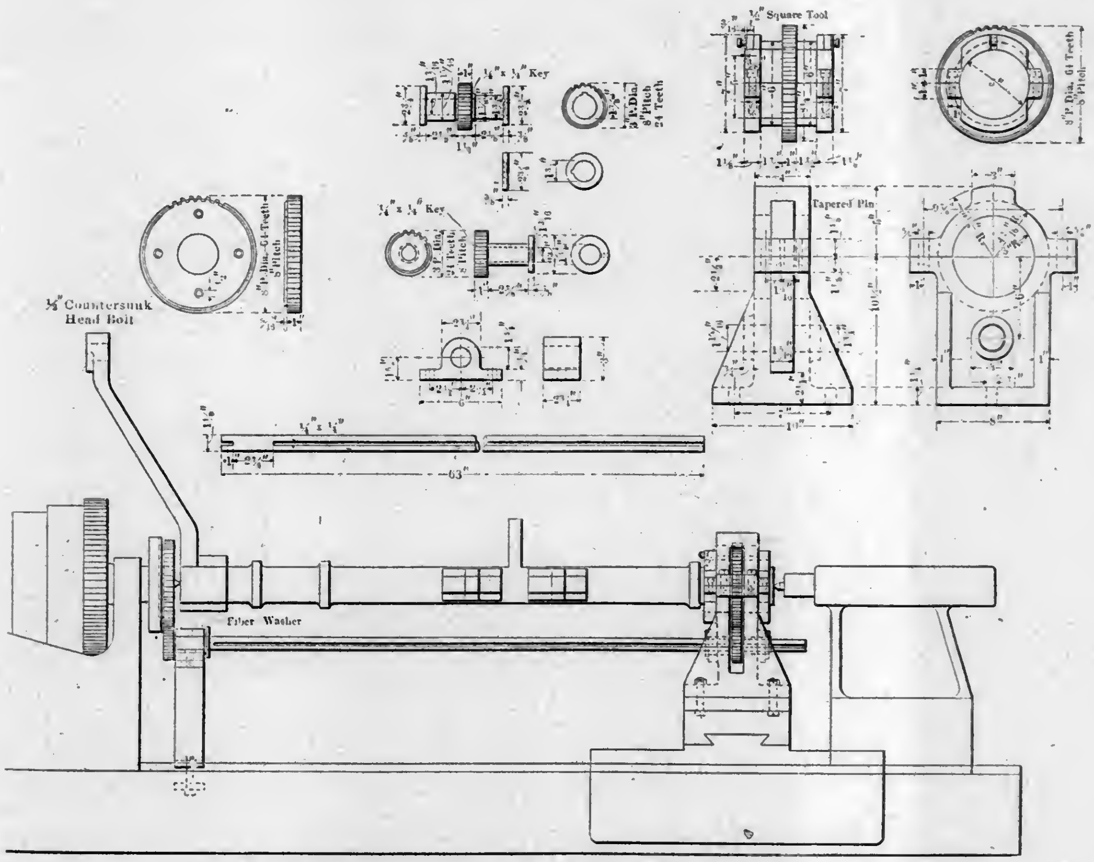
DETAILS OF PLANER CHUCK FOR SHOES AND WEDGES.

In order to grip the work securely it is only necessary to tighten up the 1¼ in. nut on the rod end of the chuck. This holds the work solidly and sufficiently to stand any kind of cut, requiring only two chuckings to complete the job. The first chucking is as shown in the photograph, where the outside of flanges, inside of flanges, and bottom of frame fit are finished. The remaining operation is merely to re-chuck the shoes and

* Macon shop, W. H. Fetner, Master Mechanic.

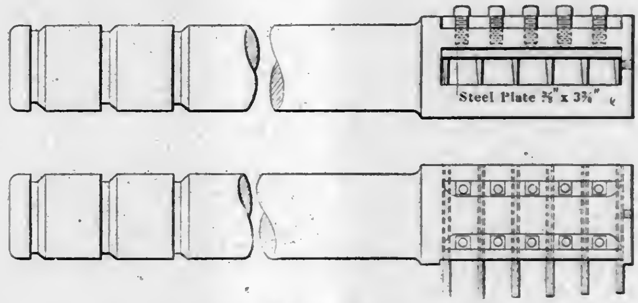
wedges to plane for the driving box fit. It will be observed that in the case illustrated a double cutter, or forked tool, is in use. This finishes the outside of the flanges in one cut, and machines the inside of both flanges and the bottom, or frame fit, of the shoes or wedges with one tool. An ingenious idea has been cleverly worked out in this connection to prevent the dragging of the tools on the back stroke of the planer. The photograph shows a small air cylinder on each head of the planer above the tool. This operates automatically with the reversing of the table, and lifts the tool clear of the work as shown until the return stroke is completed. This entire combination is probably the best arrangement yet devised for heavy, rapid and accurate shoe and wedge planing, and reflects much credit on those who so carefully worked out the details.

The question of turning the bearings of lift or tumbling shafts has been one in receipt of considerable attention in the past, and many devices of more or less merit have been evolved in various quarters to cope with it. While the majority of these, no doubt, performed the work for which they were built, it still cannot be said that any one of them has proved entirely satisfactory. The majority embody the serious fault of undue complication, a feature which necessarily implies a great deal of time in setting them up and in preliminary adjustments before any real work can begin. The difficulty, however, in some shops of securing a lathe of sufficient swing to clear the reach rod arm has necessitated a resort to some form of special device.



GENERAL ARRANGEMENT OF DEVICE FOR TURNING LIFT SHAFT BEARINGS.

That herein illustrated in detail was designed in the Macon shops for doing this work on a tumbling shaft with solid arms and inside bearings, but it can be used equally as well on an outside as on an inside bearing shaft. As it is plainly apparent, the device is surprisingly free from the multiplicity of parts which is so characteristic of the existing attempts along similar lines. It can be applied to any lathe with 24 in. swing or greater, and gives an absolutely smooth bearing, turning the shaft in about the same time that a straight shaft could be done in the usual way. Removal from the lathe can be effected in a very few minutes, and no change is required in the machine for the application of the device other than removing the tool post. It is claimed that it will do this work very much quicker than any other which has yet been designed.



GANG TOOL FOR CYLINDER PACKING.

The gang tool for cutting packing rings is one of the minor devices which have been evolved at Macon, but is equally serviceable in its own field. The drawing is self-explanatory, but attention may be called to the provision which it embodies for making any adjustment which may be necessitated by varying conditions that may arise. Although the cylinder packing rings used on this railroad are practically standardized, the fact was not overlooked that a wider or narrower ring might be required and this can be secured by separate space or filling blocks, the location of which will be readily apparent from the print.

A Flux for Use in Brazing Cast Iron can be made by mixing 1 lb. of boric acid, 4 oz. of pulverized chlorate of potash, and 3 oz. of carbonate of iron. To make a good brazed joint, the metal should be carefully cleaned and the pieces heated to a bright red before applying the flux.

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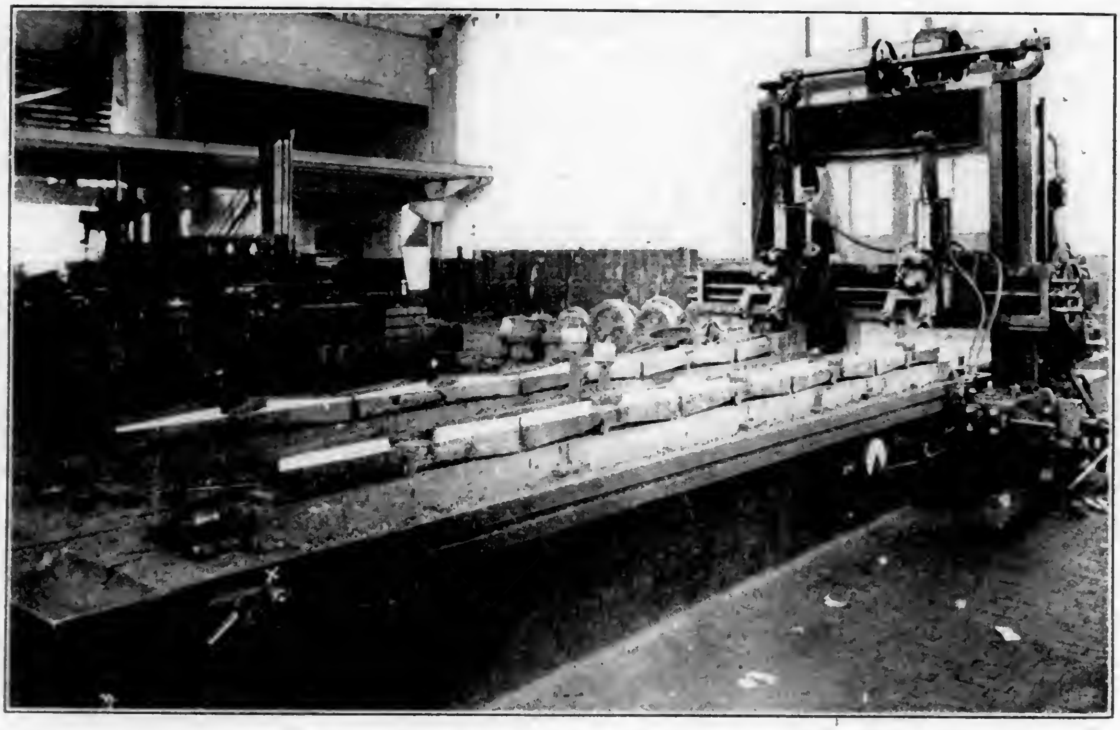

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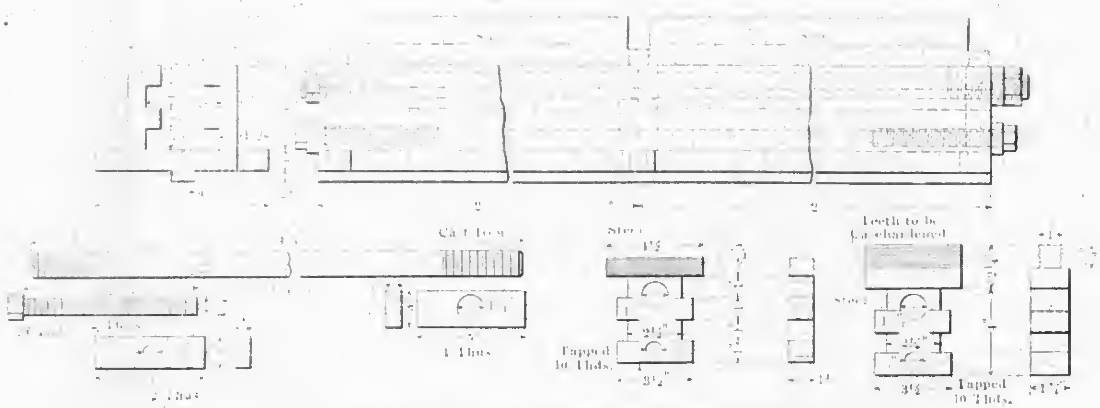

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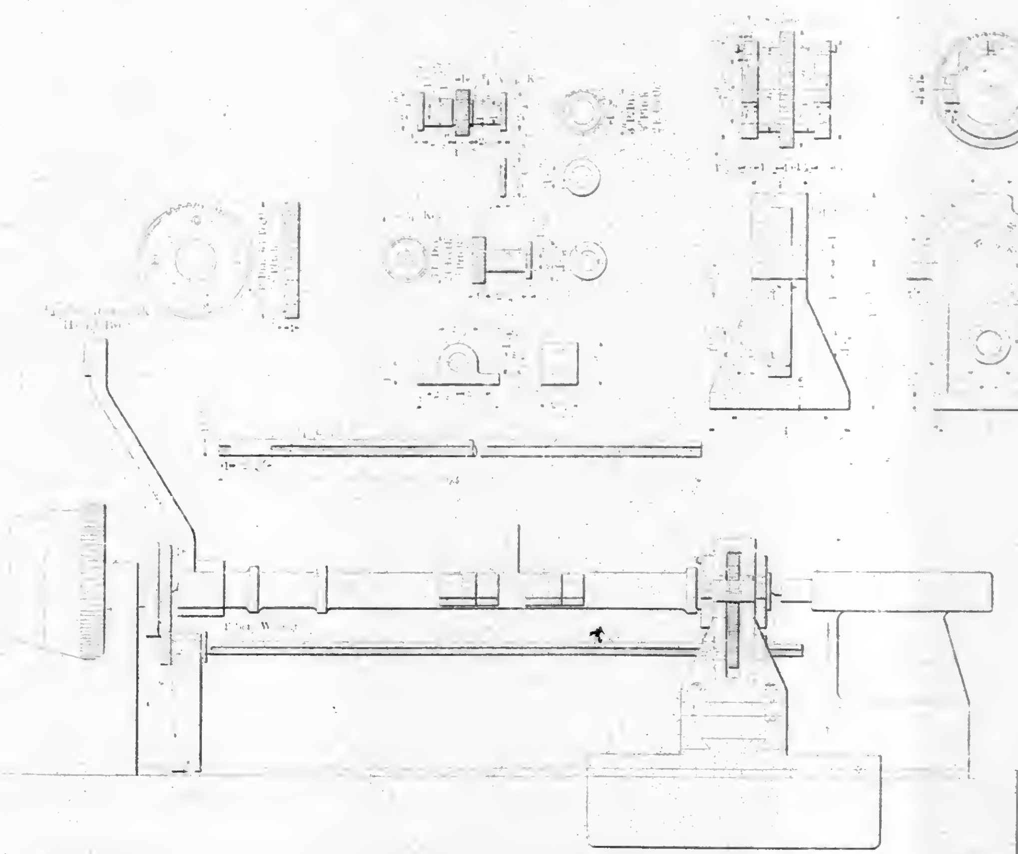

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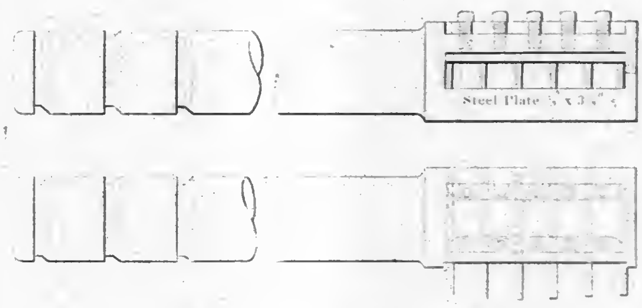

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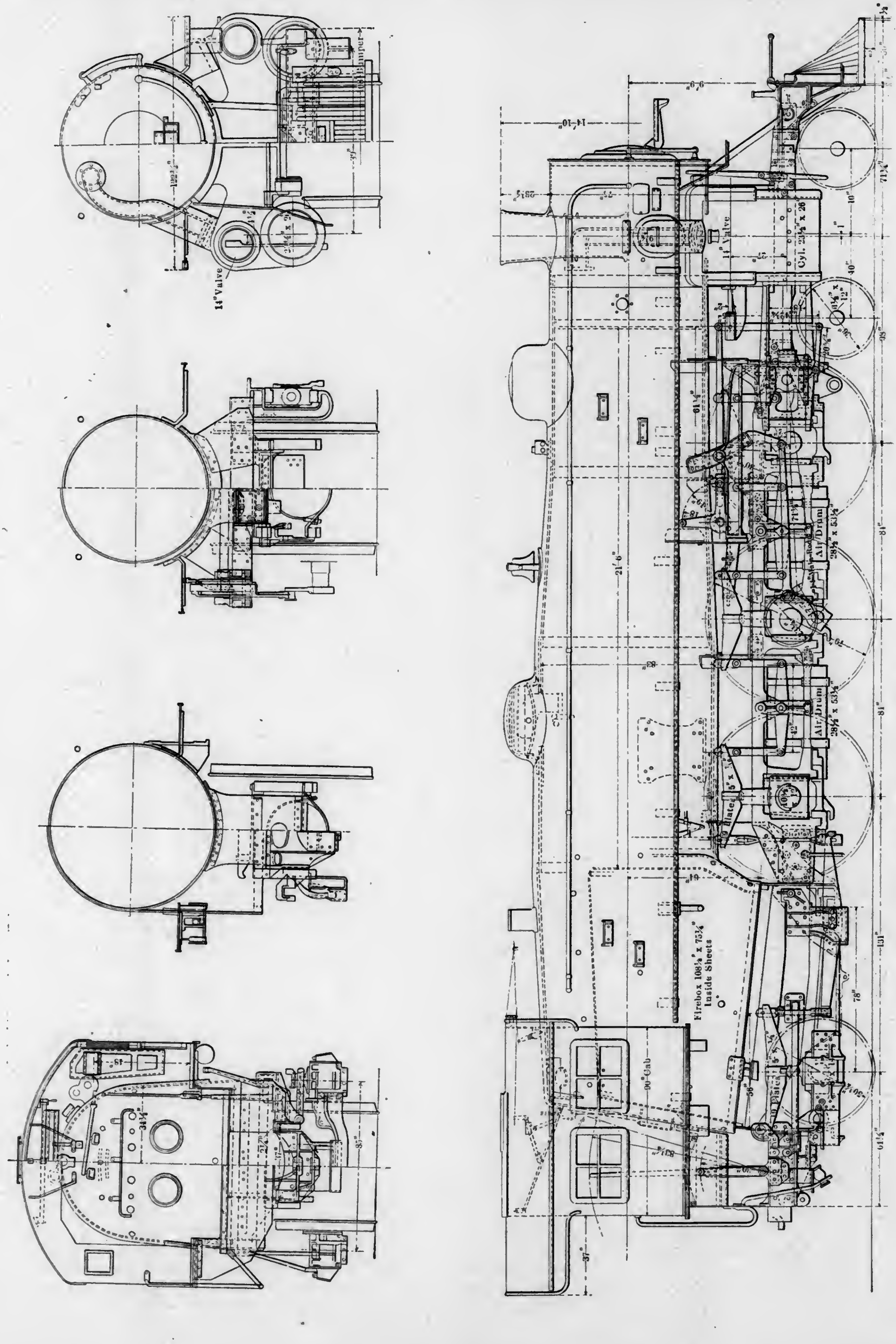
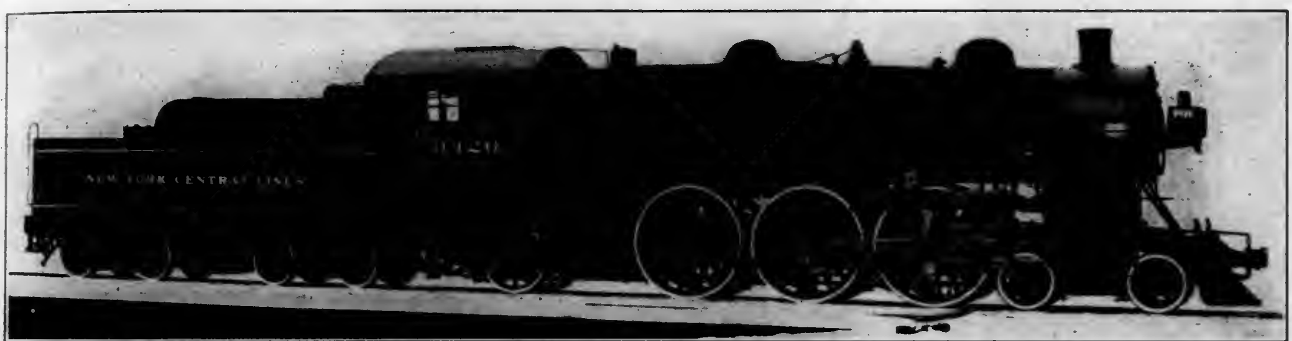


VERY POWERFUL PASSENGER LOCOMOTIVES WITH SCHMIDT SUPERHEATERS—NEW YORK CENTRAL LINES.

Pacific Type Passenger Locomotive With Schmidt Superheater

NEW YORK CENTRAL LINES.

Passenger trains, weighing over 800 tons, which must be handled at high speeds, are becoming not uncommon on many of the railways. This is particularly true on the New York Central and Pennsylvania Lines, and during winter weather and periods of heavy traffic it is often necessary to double head these trains over certain divisions. Both of these systems have Pacific or Atlantic type locomotives which are able to make schedule time with these heavy trains, but when called upon to make up time or when handicapped by severe weather they have not sufficient reserve power.



HIGH SPEED PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER—NEW YORK CENTRAL LINES.

On the New York Central Lines the standard heavy passenger engine has been for several years a Pacific type with 22 x 28 in. cylinders, 79 in. wheels and 4,210 sq. ft. of heating surface. These locomotives were fully illustrated and described in this journal on page 365 of the September, 1907, and 164 of the May, 1908, issues. The service with them in the past has been eminently satisfactory in every way and up to a comparatively recent date they had sufficient reserve power for all emergencies. The introduction of steel passenger cars and Pullmans, together with the increased passenger traffic, however, has finally brought the weight of passenger trains to a point where it was desirable to have a more powerful locomotive, and before making the last order of 20 engines of this type a careful study of the situation was made. In connection with the American Locomotive Co. experiments were carried out and it was finally decided that the increased capacity desired could be satisfactorily attained through the medium of superheated steam, therefore the last order was equipped with the latest design of Schmidt fire tube superheaters. Careful tests with a single locomotive equipped in this manner indicate that the superheater increased the boiler capacity sufficiently to allow increasing the diameter of the cylinders to 23½ in. if the stroke was shortened to 26 in. The boiler was thus redesigned and changed so as to give a distance between tube sheets of 21 ft. 6 in. instead of 20 ft., as has been standard, also for the application of the superheater tubes, but was not altered in other respects.

NEW VALVE STEM CROSSHEAD AND GUIDE.

One of the illustrations shows a view of the front end with the superheater and it will be noticed that a special design and arrangement of steam pipes has been employed. It was desired, of course, to obtain the maximum free area under the table plate in the front end and therefore the steam pipes were brought out through the shell at a point just below the center and carried into the top of the valve chamber. This arrangement not only gives a freer and better design of front end, but also greatly improves the cylinder casting and gives the most direct passage from the superheater to the steam chest.

Outside of these changes in the boiler and front end, the only other noticeable alteration from the standard engine is found in the valve gear cross head and guide, wherein the guide is secured to the valve chamber head only instead of between the guide yoke and valve chamber head, insuring the absolute alignment of the valve stem and greatly simplifying the construction. This arrangement is somewhat like that standard on the Canadian Pacific Railway.* In other respects the valve gear is the same as was previously used.

The trailer truck has also been redesigned to use a single bar frame with outside bearings in place of the previous double bar frame construction. This change has lightened the frame considerably and made it more easy for repairs and inspection.

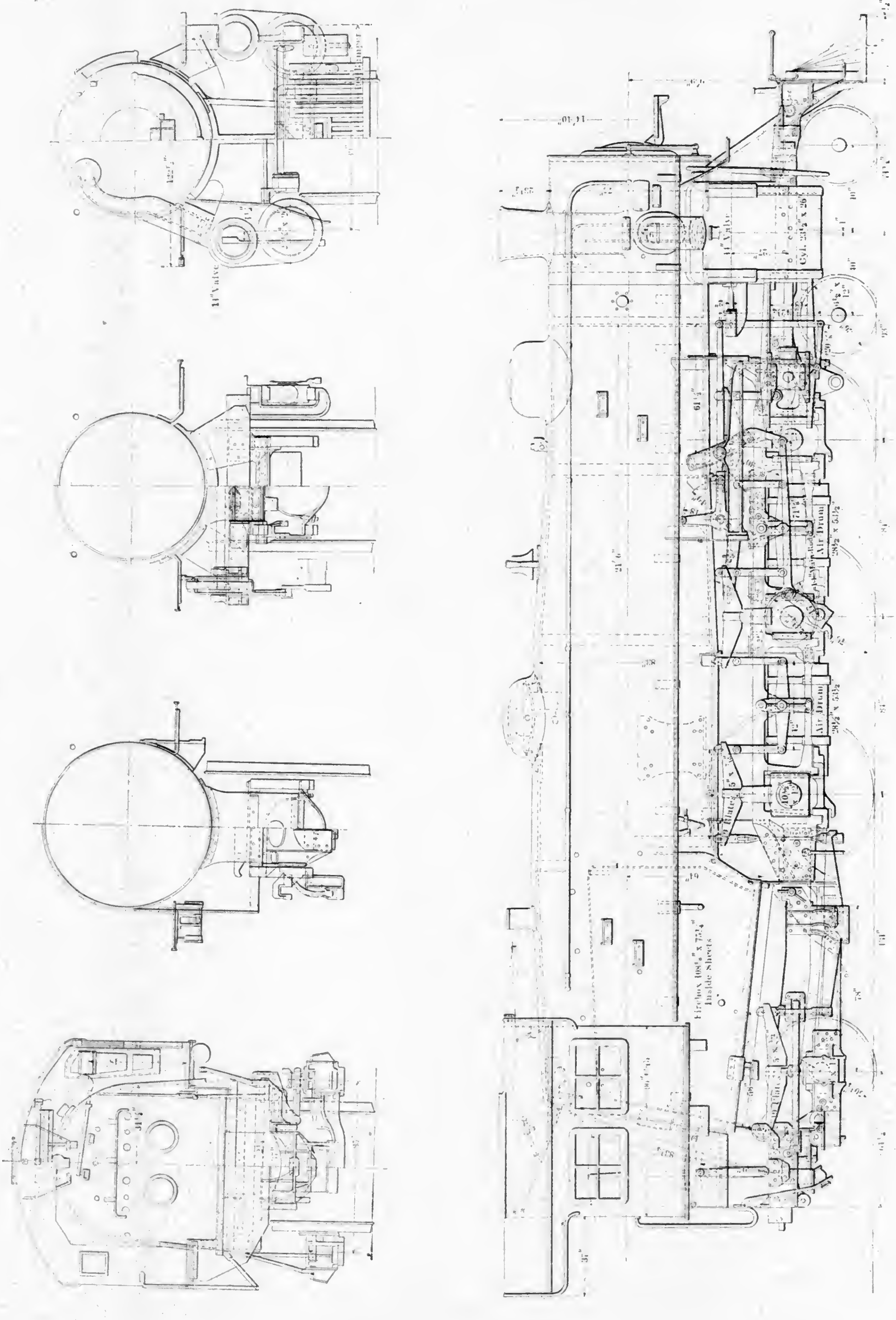
A heavy pressed steel bumper plate in U section has for the first time in American practice been used on these locomotives in place of the conventional steel casting or wooden bumper beam.

In the following table will be found the general dimensions of these locomotives as compared with the previous design:

GENERAL DATA.

	Previous design	Latest design
Fuel	Bit. Coal	Bit. Coal
Tractive effort	29,200 lbs.	30,900 lbs.

* AMERICAN ENGINEER, Jan., 1908, page 16.



VERY POWERFUL PASSENGER LOCOMOTIVES WITH SCHMIDT SUPERHEATERS—NEW YORK CENTRAL LINES.

Pacific Type Passenger Locomotive With Schmidt Superheater

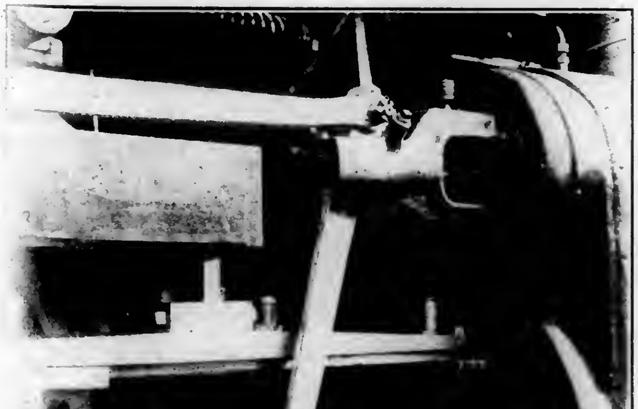
NEW YORK CENTRAL LINES

ssenger trains, weighing over 800 tons, which must be han at high speeds, are becoming not uncommon on many of the ways. This is particularly true on the New York Central Pennsylvania Lines, and during winter weather and periods avy traffic it is often necessary to double head these trains ertain divisions. Both of these systems have Pacific or e type locomotives which are able to make schedule time order of 20 engines of this type a careful study of the situation was made. In connection with the American Locomotive Co. experiments were carried out and it was finally decided that the increased capacity desired could be satisfactorily attained through the medium of superheated steam, therefore the last order was equipped with the latest design of Schmidt fire tube superheaters. Careful tests with a single locomotive equipped in this

HIGH SPEED PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER—NEW YORK CENTRAL LINES.

eavy trains, but when called upon to make up time handicapped by severe weather they have not sufficient rve power.

On the New York Central Lines the standard heavy passenger e has been for several years a Pacific type with 22 x 28 in. ders, 79 in. wheels and 4,210 sq. ft. of heating surface. These motives were fully illustrated and described in this journal page 365 of the September, 1907, and 164 of the May, 1908, The service with them in the past has been eminently sfactory in every way and up to a comparatively recent date had sufficient reserve power for all emergencies. The in uction of steel passenger cars and Pullmans, together with ncreased passenger traffic, however, has finally brought the of passenger trains to a point where it was desirable to a more powerful locomotive, and before making the last



NEW VALVE STEM CROSSHEAD AND GUIDE.

manner indicate that the superheater increased the boiler capacity sufficiently to allow increasing the diameter of the cylinders to 23½ in. if the stroke was shortened to 26 in. The boiler was thus redesigned and changed so as to give a distance between tube sheets of 21 ft. 6 in. instead of 20 ft., as has been standard, also for the application of the superheater tubes, but was not altered in other respects.

One of the illustrations shows a view of the front end with the superheater and it will be noticed that a special design and arrangement of steam pipes has been employed. It was desired of course, to obtain the maximum free area under the table plate in the front end and therefore the steam pipes were brought out through the shell at a point just below the center and carried into the top of the valve chamber. This arrangement not only gives a freer and better design of front end, but also greatly improves the cylinder casting and gives the most direct passage from the superheater to the steam chest.

Outside of these changes in the boiler and front end, the only other noticeable alteration from the standard engine is found in the valve gear cross head and guide, wherein the guide is secured to the valve chamber head only instead of between the guide yoke and valve chamber head, insuring the absolute alignment of the valve stem and greatly simplifying the construction. This arrangement is somewhat like that standard on the Canadian Pacific Railway.* In other respects the valve gear is the same as was previously used.

The trailer truck has also been redesigned to use a single bar frame with outside bearings in place of the previous double bar frame construction. This change has lightened the frame considerably and made it more easy for repairs and inspection.

A heavy pressed steel bumper plate in U section has for the first time in American practice been used on these locomotives in place of the conventional steel casting or wooden bumper beam.

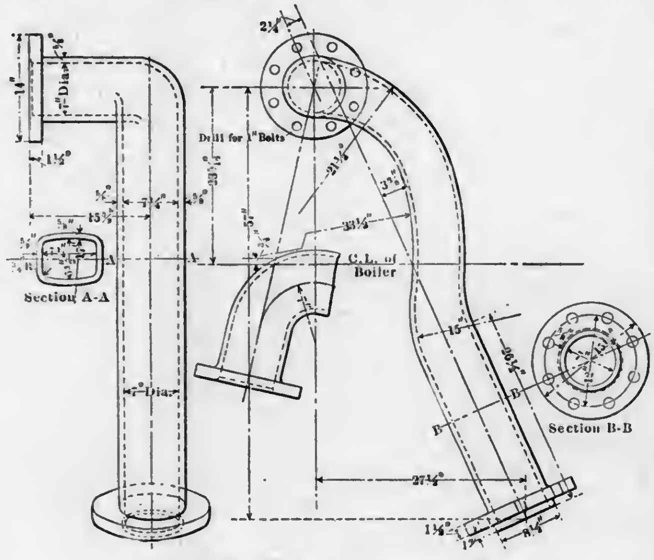
In the following table will be found the general dimensions of these locomotives as compared with the previous design:

GENERAL DATA.

	Previous design	Latest design
Fuel	Bit. Coal	Bit. Coal
Tractive effort	29,200 lbs.	30,900 lbs.

*American Engineer, Jan., 1908, page 16.

Weight in working order	266,000 lbs.	269,000 lbs.
Weight on drivers	170,500 lbs.	171,500 lbs.
Wt. of engine and tender in working order	431,000 lbs.	424,000 lbs.
Wheel base, driving	14 ft.	14 ft.
Wheel base, total	36 ft. 6 in.	36 ft. 6 in.
Wheel base, engine and tender	67 ft. 11 in.	67 ft. 11 in.
RATIOS.		
Weight on drivers ÷ tractive effort	5.84	5.55
Total weight ÷ tractive effort	9.11	8.71
Tractive effort × diam. drivers ÷ heating surface	550.00	534.00*
Total heating surface ÷ grate area	74.50	81.00*
Firebox heating surface ÷ total heating surface, %	5.35	5.07*
Weight on drivers ÷ total heating surface	40.70	37.50*



STEAM PIPES ON SUPERHEATER LOCOMOTIVE.

Total weight ÷ total heating surface	63.10	59.00*
Volume both cylinders, cu. ft.	12.32	13.10
Total heating surface ÷ vol. cylinders	341.00	348.00*
Grate area ÷ vol. cylinders	4.58	4.32
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	22 x 28	23½ x 26
VALVES.		
Kind	Piston	Piston
Diameter	14 in.	14 in.
Greatest travel	6 in.	7 in.
Outside lap	1 in.	1⅛ in.
Inside clearance	⅛ in.	⅛ in.
Lead in full gear	¼ in.	¼ in.
WHEELS.		
Driving, diameter over tires	79 in.	79 in.
Driving, thickness of tires	3½ in.	3½ in.
Driving journals, main, diam. and length	10½ x 12 in.	10½ x 12 in.
Engine truck wheels, diameter	36 in.	36 in.
Engine truck, journals	6½ x 12 in.	6½ x 12 in.
Trailing truck wheels, diameter	50¼ in.	50¼ in.
Trailing truck, journals	8 x 14 in.	8 x 14 in.
BOILER.		
Style	Conical	Conical
Working pressure	200 lbs.	200 lbs.
Outside diameter of first ring	72 in.	72 in.
Firebox, width and length	75¼ x 108⅛ in.	75¼ x 108⅛ in.
Firebox plates, thickness	⅜ & ½ in.	⅜ & ½ in.
Firebox, water space	4½ in.	4½ in.
Tubes, number and outside diameter	382—2 in.	175—2¼ in. & 32—5 in.
Tubes, length	20 ft.	21 ft. 6 in.
Heating surface, tubes	3,981.6 sq. ft.	3,192.9 sq. ft.
Heating surface, firebox	228.3 sq. ft.	231.2 sq. ft.
Heating surface total	4,209.9	3,424.1 sq. ft.
Superheater heating surface	....	755 sq. ft.
Grate area	56.5 sq. ft.	56.5 sq. ft.
Smokestack, diameter	20 in.	19½ in.
Smokestack, height above rail	14 ft. 7⅞ in.	14 ft. 10 in.
TENDER.		
Frame	13 in. chan.	13 in. chan.
Wheels, diameter	36 in.	36 in.
Journals, diameter and length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,000 gals.	7,500 gals.
Coal capacity	14 tons	12 tons

* Heating surface = evaporating surface + 1.5 times superheating surface.

It is Reported that the Russian Government contemplates the improvement of the existing Siberian Railway and creating duplicate approaches both in European Russia and the Far East. When these works are completed, in 1915, the imperial treasury will have expended on the Siberian Railway somewhat over $1,000,000,000, which includes both cost of construction and loss on exploitation. In exchange for this Russia will have a complete double-track system from the Urals to the Pacific, with double approaches, of a total length of 6,844 miles.

THREE YEARS TESTS OF FEED WATER HEATING BY THE TREVITHICK SYSTEM

Some surprising results in increased economy are indicated by the returns from the elaborate tests of feed water heating on locomotives just completed on the Egyptian State Railways. These tests began in March, 1907, and have been continued in connection with many types of locomotives and under all conditions of service. The final summaries are of extreme interest as the economy is shown to be upwards of 20 per cent. in connection with engines equipped with the feed water appliance over those not so equipped, and the tests have served the purpose of demonstrating as facts many points formerly regarded as largely theoretical.

Attention was first attracted to this matter toward the end of 1907, when F. H. Trevithick, locomotive, car and wagon superintendent of the Egyptian State Railways, applied a feed water heater of his own design to an engine of those roads.* In this instance, which has been followed throughout all the subsequent tests with few modifications the feed water is drawn from the tender and forced into the boiler by means of a horizontal duplex pump located on the right side just ahead of the cab. This pump takes steam at boiler pressure and delivers its exhaust into the first section of the feed water heater which is located on the suction side of the pump. This first heater is vertical and contains nineteen ⅝ in. tubes, which are connected to headers at each end, the upper header being connected to the exhaust pipe from the pump, and the lower header having an opening to the atmosphere. The feed water circulates around the outside of the tubes.

On leaving the pump the water traverses in succession two other heaters, one on either side of the smoke box. The one on the right is divided into two compartments by a partition, so that the water traverses twice the length of the heater in passing through. It then goes to the left heater, in which there is no dividing partition. These two heaters are heated by part of

VIEW SHOWING SCHMIDT SUPERHEATER AND ARRANGEMENT OF STEAM PIPES—NEW YORK CENTRAL 4-6-2 LOCOMOTIVES.

the exhaust steam from the cylinders. From these the water passes to the larger heater in the front end, which consists of an annular chamber containing 265 tubes 1 in. diameter and 18 in. long, arranged in three concentric rings and heated by the exhaust gases passing through the tubes. The total section of the heater tubes, which is but little larger than the section of the smokestack, is entirely utilized, and their position in reference to the fire tubes assures a perfect separation of the escape-

* See American Engineer, November, 1907, page 456

gases to the interior of them all. From this heater the water passes to the boiler through the usual check valves.

As has been mentioned the tests were made in all services, fast express, light passenger, freight and switching, and during the various applications of the heater to various types some minor changes were made in the relative proportion of the parts, but the basic principle was not affected, and the description given above will serve to illustrate the system.

Taking first the records of engine 711 for the years 1907, 1908 and 1909. This engine was one of a class of thirty, and it shows up very well when compared with the rest of its class. The figures in Table I below are taken from the ordinary registers, and therefore show all coal booked to the engines. The mileage given is train mileage only, and the weight of train is calculated on the commonly used service method abroad of rating a six-wheel passenger coach as one unit of 15 tons, and a coach with two four-wheel trucks as two units, or 30 tons, the figures agreeing very closely with the average for the rolling stock used on the train service in question on the Egyptian State Railways. During the period covered by these records, engine 711 was taken into the shop, and for purposes of certain experimental work, had her heaters removed, subsequently working without them for some time. The records for this engine thus afford an independent and unintentional check. Table I gives the averages from the coal records for the whole class of 30 engines, and also for engine 711 for the period during which it was at work without heaters.

TABLE I.—COMPARISON OF ENGINE NO. 711 WITHOUT AND WITH HEATERS, AND WITH TWENTY-NINE SISTER ENGINES WITHOUT HEATERS, UNDER ORDINARY RUNNING CONDITIONS.

	Engine No. 711 Without Heaters.	Engine No. 711 With Heaters.	29 Sister-Engines Without Heaters.
Average miles per train	138	127.8	136
Average pounds of coal per train	5,660	4,595	5,497
Average pounds of coal per mile	41	35.9	40.2
Average load behind tender, tons	249.6	281.6	231
Average pounds of coal per ton mile	0.1643	0.1276	0.1749
Difference in favor of engine No. 711 with heaters, on coal per ton mile		0.036 lb. = 22%	0.0473 lb. = 27%

The high figure of 27 per cent. is probably due in part to the fact that at one time and another engine 711 has been engaged in special trials, and the coal booked to it, therefore, has at times been more carefully checked than is usual under ordinary running conditions.

The record of engine 677, an inside cylinder 4-4-2 locomotive, is also of much interest. This engine has cylinders 18 in. by 26 in., and driving wheels 6 ft. 3 in. in diameter. The boiler is fitted with a Belpaire box, and contains 184 2-in. flues, 15 ft. 11¼ in. between flue sheets, giving 1535.5 sq. ft. heating surface. The firebox provides 140.25 sq. ft., making a total of 1675.75 sq. ft. The grate area is 24 sq. ft. The total weight of the engine in working order is 63 tons, of which 35 tons are on the driving wheels. The heaters of No. 677 are similar to those of No. 711, except that the smokebox heater is of rather larger heating surface capacity, having 258 sq. ft. heating surface and a capacity of 70 gallons.

During two months in 1907 this engine ran without its smokebox heater, as it required some alterations when delivered to the railway, before it could be brought into use. In February, 1908, the heaters were not used, and the effect of the flue gases upon it, when out of service, was watched. Again, in 1909. on the smokebox heater needing re-tubing, the arrangement was removed. The results taken from the ordinary registers are as indicated in Table II, for the period March, 1907, to December, 1909.

TABLE II.—WORKING OF ENGINE NO. 677 WITH AND WITHOUT FEED WATER HEATERS.

	With Heaters.	Without Heaters.
Average miles per train	135.7	135.9
Average pounds of coal per train	5,024	6,138
Average pounds of coal per mile	37	45.1
Average weight behind tender, tons	280	278.4
Average pounds of coal per ton mile	0.1322	0.1622
Difference in favor of heaters on coal per ton mile	0.0300 = 18%	

From the records for this engine another set of figures has been abstracted, showing the comparison for six months' working only, with and without heaters, over certain periods for which weather conditions were approximately similar. These figures differ somewhat from those given in the above table, the loading during the periods in question showing greater difference than above. For these periods for which the results are really more strictly comparable, the coal per ton-mile with the heaters in use shows economy amounting to 20.5 per cent. All of the figures in the tables, it will be noted, are large and the effect on the coal bill well worth considering.

EXTENSION OF TIME AND MODIFICATION OF SAFETY APPLIANCE RULES

After conference with representatives of the railways and of the employees' brotherhoods, a form of order has been drawn up by the Interstate Commerce Commission providing that the time for complying with the law respecting brakes, ladder clearance, and certain other features of freight car safetly appliances, should be extended for five years from July 1, 1911; the time to make similar changes on passenger cars for three years from the same date; on road locomotives two years, and on switching locomotives one year. The bill now before Congress, appropriating money for the expenses of the Interstate Commerce Commission for the next fiscal year, contains a clause empowering the Commission to postpone the date of compliance with this law, not only as regards old cars, but also as regards cars put in service up to July 1, 1911. As the law was passed originally, the Commission could not extend the time limit except in relation to cars which were in service April 14, 1910.

At a final meeting before the Commission in Feb., at which were present five representatives from the committee of the railways, five of the committee of railway employees, and five for the special committee of the agents of the Commission, the following stipulations and modifications in the new rules were agreed upon:

(a) That carriers will not be required to change the brakes from right to left side on steel or steel underframe cars with platform end sills, or to change the end ladders on such cars, except when such appliances are renewed, at which time they must be made to comply with the prescribed standards.

(b) That carriers will be granted an extension of five years' time from July 1, 1911, to change the location of brakes on all other cars to comply with the prescribed standards.

(c) That carriers will be granted an extension of five years' time from July 1, 1911, to comply with the prescribed standards on other brake specifications on all cars.

(d) That carriers will not be required to make changes to secure additonal end-ladder clearance on cars that have ten or more inches end-ladder clearance, within thirty inches of side of car, until car is shopped for work amounting to practically the rebuilding of the body of the car, at which time they must be made to comply with the prescribed standards.

(e) That carriers will be granted an extension of five years' time from July 1, 1911, to change cars having less than ten inches end-ladder clearance, within 30 inches of side of car, to comply with the prescribed standards.

(f) That carriers will be granted an extension of five years' time from July 1, 1911, to change and apply all other appliances on freight train cars to comply with the prescribed standards, except that when a car is shopped for work amounting to practically rebuilding the body of the car, it must then be equipped with the prescribed standards in respect to handholds, running boards, ladders, sillsteps, and brake staffs. Provided, that the extension of time herein granted is not to be construed to relieve a carrier from complying with the provisions of Section 4 of the act of March 2, 1893, as amended April 1, 1896, and March 2, 1903.

(g) That carriers will not be required to change the location of handlholds (except end-handholds under endsills, ladders, sillsteps, brake wheels and brake staffs), on freight train cars the appliances are within three inches of the required location, ex-

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Wheel base, total	36 ft. 6 in.	36 ft. 6 in.
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Weight on drivers ÷ tractive effort	5.84	5.55
Total weight ÷ tractive effort	9.11	8.71
Tractive effort × diam. drivers ÷ heating surface	550.00	534.00*
Total heating surface ÷ grate area	74.50	81.00*
Firebox heating surface ÷ total heating surface, %	5.35	5.07*
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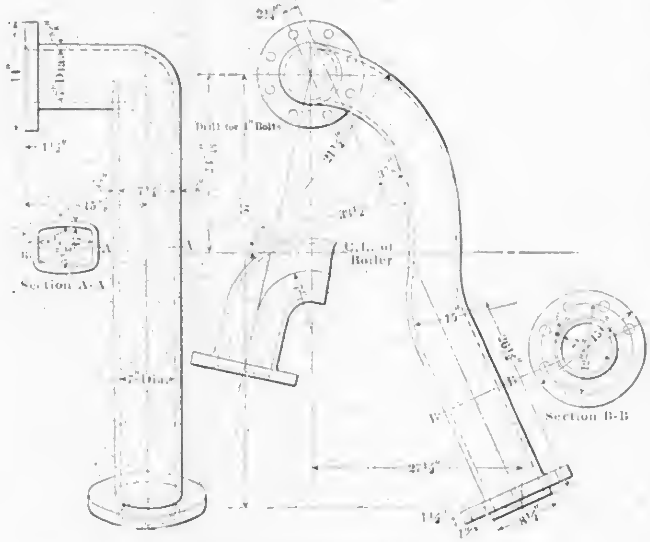

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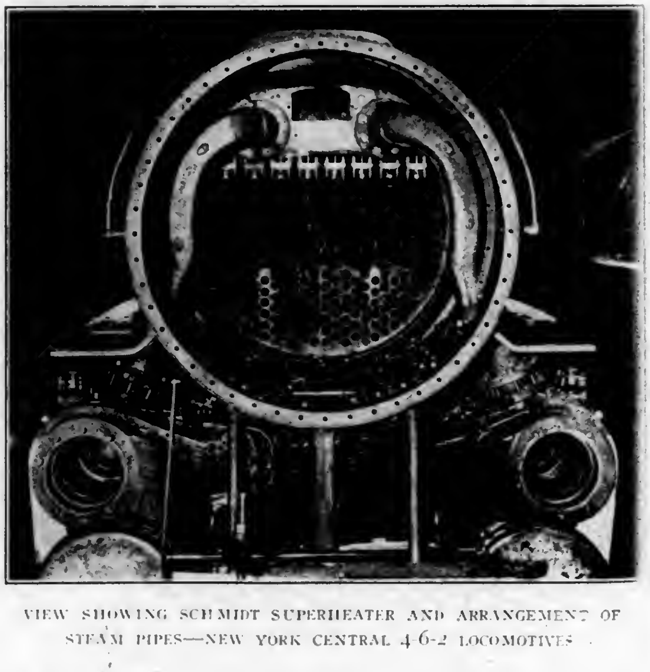

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rom the records for this engine another set of figures has n abstracted, showing the comparison for six months' working only, with and without heaters, over certain periods for which weather conditions were approximately similar. These figures differ somewhat from those given in the above table, the loading during the periods in question showing greater difference than above. For these periods for which the results are really more strictly comparable, the coal per ton-mile with the heaters in use shows economy amounting to 20.5 per cent. All of the figures in the tables, it will be noted, are large and the effect on the coal bill well worth considering.

EXTENSION OF TIME AND MODIFICATION OF SAFETY APPLIANCE RULES

After conference with representatives of the railways and of the employees' brotherhoods, a form of order has been drawn up by the Interstate Commerce Commission providing that the time for complying with the law respecting brakes, ladder clearance, and certain other features of freight car safety appliances, should be extended for five years from July 1, 1911; the time to make similar changes on passenger cars for three years from the same date; on road locomotives two years, and on switching locomotives one year. The bill now before Congress, appropriating money for the expenses of the Interstate Commerce Commission for the next fiscal year, contains a clause empowering the Commission to postpone the date of compliance with this law, not only as regards old cars, but also as regards cars put in service up to July 1, 1911. As the law was passed originally, the Commission could not extend the time limit except in relation to cars which were in service April 14, 1910.

At a final meeting before the Commission in Feb., at which were present five representatives from the committee of the railways, five of the committee of railway employees, and five for the special committee of the agents of the Commission, the following stipulations and modifications in the new rules were agreed upon:

(a) That carriers will not be required to change the brakes from right to left side on steel or steel underframe cars with platform end sills, or to change the end ladders on such cars, except when such appliances are renewed, at which time they must be made to comply with the prescribed standards.

(b) That carriers will be granted an extension of five years' time from July 1, 1911, to change the location of brakes on all other cars to comply with the prescribed standards.

(c) That carriers will be granted an extension of five years' time from July 1, 1911, to comply with the prescribed standards on other brake specifications on all cars.

(d) That carriers will not be required to make changes to secure additonal end-ladder clearance on cars that have ten or more inches end-ladder clearance, within thirty inches of side of car, until car is shopped for work amounting to practically the rebuilding of the body of the car, at which time they must be made to comply with the prescribed standards.

(e) That carriers will be granted an extension of five years' time from July 1, 1911, to change cars having less than ten inches end-ladder clearance, within 30 inches of side of car, to comply with the prescribed standards.

(f) That carriers will be granted an extension of five years' time from July 1, 1911, to change and apply all other appliances on freight train cars to comply with the prescribed standards, except that when a car is shopped for work amounting to practically rebuilding the body of the car, it must then be equipped with the prescribed standards in respect to handholds, running boards, ladders, sillsteps, and brake staffs. Provided, that the extension of time herein granted is not to be construed to relieve a carrier from complying with the provisions of Section 4 of the act of March 2, 1893, as amended April 1, 1896, and March 2, 1903.

(g) That carriers will not be required to change the location of handholds (except end-handholds under endsills, ladders, sill-steps, brake wheels and brake staffs), on freight train cars the appliances are within three inches of the required location, ex-

cept that when cars undergo regular repairs they must then be made to comply with the required standards.

(h) That carriers will be granted an extension of three years' time from July 1, 1911, to change passenger train cars to comply with the prescribed standards.

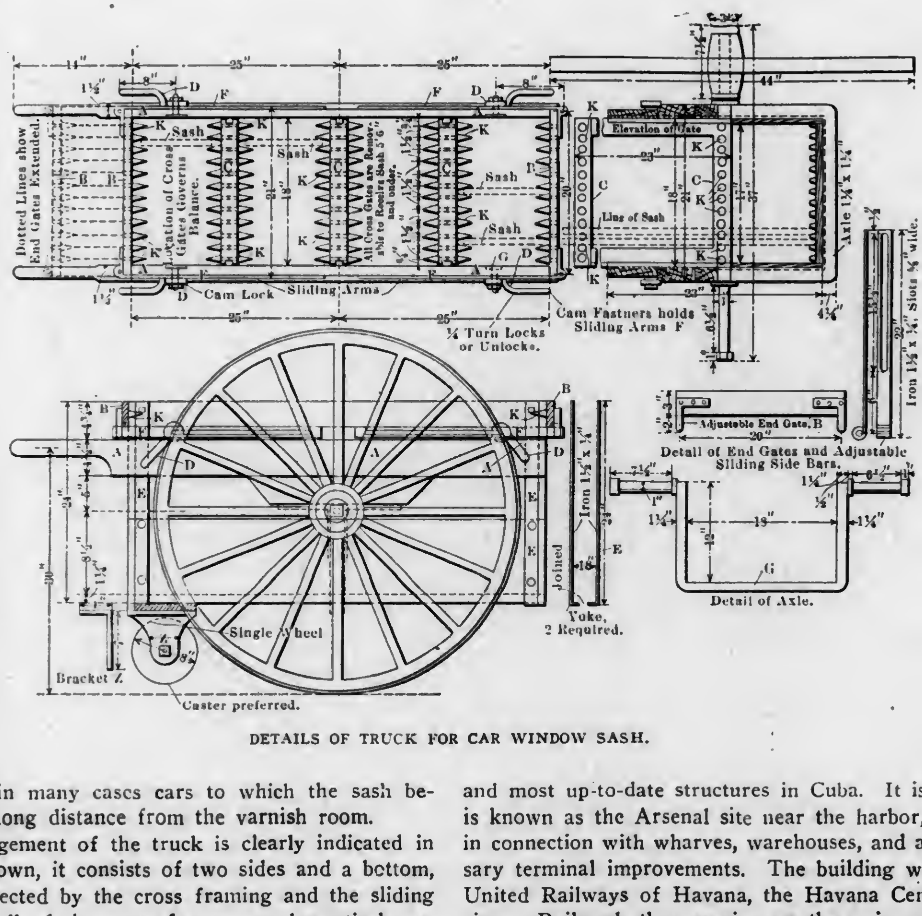
(i) That carriers will be granted an extension of one year's time from july 1, 1911, to change switching locomotives to comply with the prescribed standards.

(j) That carriers will be granted an extension of two years' time from July 1, 1911, to change all other locomotives to comply with the prescribed standards.

It will, of course, be understood that all these extensions of time apply to equipment that is already built and in use, and not to new equipment.

HAND TRUCK FOR CAR SASH

A very handy truck for distributing newly varnished car window sash, of which the working drawing is reproduced herewith, is being used to much advantage in the Readville shops of the New York, New Haven and Hartford Railroad. It permits the loading of sash so that they will not come in contact with one another or become soiled and does away with quite a large gang of men who were obliged to carry the sash singly previous to its advent. In a large shop where from four to five hundred are being distributed every day this labor-saving becomes no insignificant item, as in many cases cars to which the sash belongs are located a long distance from the varnish room.



DETAILS OF TRUCK FOR CAR WINDOW SASH.

The general arrangement of the truck is clearly indicated in the drawing. As shown, it consists of two sides and a bottom, the sides being connected by the cross framing and the sliding end gates. One or all of the cross frames can be entirely removed when required, thus permitting sash five feet or more in width to be carried by adjusting the side gates and sliding ends. All of the cross gates or frames (C) and the end gates (B) are provided with cone-shaped pins, or separators, shown at (K), which hold the sash from striking one another while in the truck. The sliding ends (E) are held and carried by the arms (F), which slide in guides or grooves on the sides of the truck, and are fastened at any point by the handle cam nuts (D) which lock or unlock with a one-quarter turn.

One-half the sash equipment for a long car can be loaded on this truck and moved to any point of the shop by a boy. One of them has been in service for two years and two others have since been added. The cost of production is very small and it cannot fail to prove a valuable addition to any car shop.

Nine More Electric Locomotives, aggregating about 40,000 horsepower, have been ordered by the Pennsylvania Railroad from the Westinghouse Electric and Manufacturing Company. The new locomotives will be of the same type as those which are now being operated in the Manhattan Terminal, New York City, and will supplement the twenty-four already in use. The Westinghouse Electric and Manufacturing Company has contracted to have the new locomotives completed by July 1st, 1911. The cabs, frames, running gear and mechanical parts will be built by the Pennsylvania Railroad at their Juniata shops. The air brakes will be supplied by the Westinghoue Air Brake Company. The electrical equipments will be built and the complete locomotives assembled at the East Pittsburg works of the Westinghouse Electric and Manufacturing Company.

New Terminal for Cuban Railroads.—The new passenger terminal in Havana, Cuba, which is in the course of erection for the Havana Terminal Company, will be one of the finest and most up-to-date structures in Cuba. It is situated on what is known as the Arsenal site near the harbor, and will be built in connection with wharves, warehouses, and all the other necessary terminal improvements. The building will be used by the United Railways of Havana, the Havana Central, and the Marianao Railroad, thus serving as the union passenger terminal for the city of Havana. As tourists' traveling is becoming more important every year, the station has been designed to take care of this need, and has a capacity which will suffice to satisfy all requirements for many years to come.

Locomotives Burn 100 Million Tons of Coal a year, or one fifth of the total amount mined annually in the United States

Road Test of 2-6-6-2 Type Locomotive

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

During the months of December and January last the Chicago, Milwaukee & St. Paul Ry. received 25 Mallet compound locomotives built by the Schenectady works of the American Locomotive Co.* These locomotives are of the 2-6-6-2 type and have a 83¾ in. boiler with 439 2¼ in. tubes 24 ft. in length, and a combustion chamber 78 in. in length. This gives a heating surface in the tubes of 6,182 sq. ft. and a total heating surface of 6,554.6 sq. ft., the ratio being 90.5 sq. ft. of heating surface to 1 sq. ft. of grate area. Other general dimensions and ratios are given in the following table:

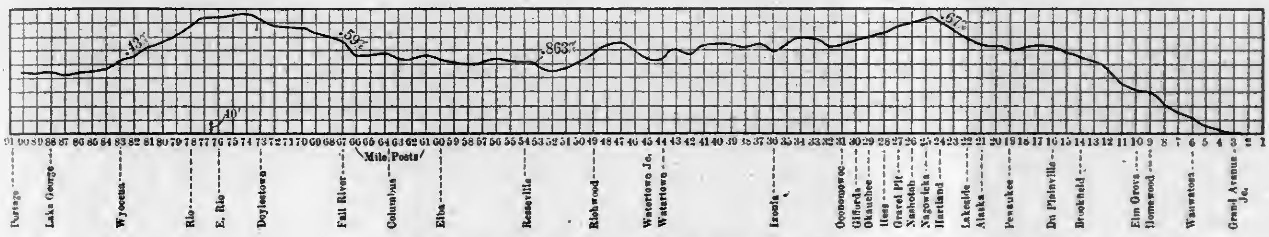
GENERAL DATA.

Fuel	Bit. Coal
Maximum tractive effort	75,000 lbs.
Weight in working order	390,000 lbs.
Weight on drivers	323,500 lbs.
Weight of engine and tender in working order	555,700 lbs.
Wheel base, driving	30 ft. 6 in.
Wheel base, total	48 ft.
RATIOS.	
Weight on drivers ÷ tractive effort	4.30
Total weight ÷ tractive effort	5.20
Tractive effort × diam. drivers ÷ heating surface	653.00
Firebox heating surface ÷ total heating surface, per cent	5.69
Weight on drivers ÷ total heating surface	49.30
Total weight ÷ total heating surface	59.50
Volume equivalent simple cylinders, cu. ft	22.80
Total heating surface ÷ vol. cylinders	288.00
Grate area ÷ vol. cylinders	3.18
CYLINDERS.	
Kind	Mellin Compound
Diameter	23½ & 37 in.
Stroke	30 in.
VALVES.	
Kind H. P	Piston
Kind L. P	Slide
Greatest travel	6 in.
Outside lap H. P	1 in.
Outside lap L. P	⅞ in.
Inside clearance	5/16 in.
Lead	3/16 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	10 x 13 in.
BOILER.	
Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	83¾ in.
Firebox, length and width	108 1/16 x 96¼ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F. 5 in., S. & B. 4½ in.
Grate area	72.3 sq. ft.

While these engines were designed for pusher service on the Chicago, Milwaukee & Puget Sound Ry., where the mountain grades range from 1 per cent. to 2.74 per cent., 14 of them are still working in the Milwaukee district, some in regular train service on the Chicago, Milwaukee & La Crosse Divisions and some in transfer and hump yard switching service.

Recently one of these engines, No. 5000, was given a complete road test, with maximum tonnage, from Milwaukee to Portage and return. The distance between these points is 91 miles and is over a division with ruling grades of one-half of one per cent., except about 1½ miles with a grade of .67 per cent. There is one short velocity grade, about 1,000 ft., of one per cent. The profile of the division is shown in the accompanying illustration.

Standard methods for locomotive testing were generally followed and the greatest care was taken to secure accurate and reliable data. The coal used was carefully weighed as it was put on to the tender and two observers checked the results. The fuel for firing up in the enginehouse and for taking the engine to the yards and the amount used after the engine left the train, was taken from a supply in sacks placed on the rear of the tender. The surplus coal at the end of the run was carefully weighed off and proper credit given. Water delivered to the boiler was measured by metering it through three 3 in. Worthington hot water meters, which had been carefully calibrated and the loss from the injector overflow was caught and weighed. The draft in the smokebox and firebox were measured by U tube manometers containing water. The temperature readings for smokebox gases were taken through the medium of the Hookings thermo-electric couple pyrometer. The dynamometer car used was a new one built at the Milwaukee shops and is of the spring type, with a capacity up to 110,000 lbs. The record of the dynamometer contained the usual speed, reverse levers and throttle position, etc.



PROFILE OF DIVISION ON WHICH TEST WAS MADE.

The first run was made on January 23 from Milwaukee to Portage, the train behind the tender consisting of 55 loaded cars, dynamometer car and caboose, making 2,555 tons. On the following day the return trip was made with a train consisting of 43 loads, 79 empties, dynamometer car and caboose, giving a total tonnage of 3,050 as far as Watertown Junction; at this point the tonnage was cut down to 36 loads, 79 empties, dynamometer car and caboose, giving a tonnage of 2,775.

The performance of the locomotive, as indicated by the tests, was most satisfactory. It was shown beyond doubt that the boiler would furnish steam for the maximum horsepower required by the locomotive, which the indicator cards showed reached a maximum of 1,753 on a ½ per cent. grade.

In the following table are given some of the general average results of the tests:

Run	Milwaukee to Portage	Portage to Milwaukee
Distance	91 miles	91 miles
Date	Jan. 23	Jan. 24
Temperature	35°	45°
Time on road	7 hrs. 12 min.	6 hrs. 37 min.
Running time	5 hrs. 23 min.	5 hrs. 41 min.
Speed, average	16.7 m. p. h.	16 m. p. h.
Tonnage	2555 tons	3050-2775
Average steam pressure	197.3 lbs.	198 lbs.
Vacuum in front end	2.96 in. water	2.97 in. water
Firebox vacuum	1.48 in. water	1.98 in. water
Temperature front end	509° F.	511° F.
Temperature feed water	44.6° F.	41.6° F.
Coal fired	25,210 lbs.	28500 lbs.
Water delivered to boiler	203,258 lbs.	222,375 lbs.
Lbs. water per lb. coal	8.07 lbs.	7.8 lbs.
Water evaporated from and at 212° per lb. coal	9.9 lbs.	9.6 lbs.
Ton miles	229,950	265,450
Coal per 100 ton miles	10.96 lbs.	10.73 lbs.
Water per 100 ton miles	88.39 lbs.	83.77 lbs.
Water evaporated per sq. ft. heating surface per hour (running time)	5.74 lbs.	5.96 lbs.
Coal burned per sq. ft. grate area per hour (running time)	64.6 lbs.	69.1 lbs.

On the first day's run the speed varied between 10 and 35 miles per hour, averaging 16.7 miles per hour. On the return trip speeds of from 10 to 30 miles were maintained as far as

* For fully illustrated description, see page 90, March issue, AMERICAN ENGINEER.

Watertown Junction, and from 12 to 29 miles per hour from there to Milwaukee. The maximum draw bar pull registered was 100,000 lbs., starting the train out from the water tank at Columbus on the second day's test. The engine at this time was of course working simple. A draw bar pull of 95,000 lbs. was developed for a distance of 100 ft. at another start and 93,500 at another time. The engine only required about 100 ft. simple operation before being able to handle the train in compound. A draw bar pull of 76,500 lbs. working compound was the maximum registered.

The water rate from the indicator cards showed a consumption of 23.11 lbs. per indicated horsepower hour, the cut-off being from 65 to 75 per cent. It is stated by J. F. DeVoy, assistant superintendent of motive power, under whose direction the tests were carried out, that the locomotive showed an economy over simple engines in the same service of about 21 per cent. in regard to fuel and water. The locomotive, however, was in first-class conditon and it is probable that a fuel economy of from 15 to 20 per cent. can be expected on an average.

Heating Test of Driving Tires

AN INTERESTING RESEARCH INTO THIS GENERAL SUBJECT RECENTLY COMPLETED ON THE CHICAGO AND NORTHWESTERN RAILROAD BRINGS TO LIGHT SOME SURPRISING DATA IN REGARD TO THE GREAT LOSS WHICH ORDINARILY ATTENDS THE OPERATION OF TIRE SETTING.

V. T. Kropidlowski.

On the road where the writer is employed he recently conducted some very interesting tests in connection with the removal from the wheel centers of locomotive driving tires, and while there was nothing unusual in regard to the process employed, some exceedingly valuable data has been gathered on the operation from an economical standpoint. In one test the tires removed were 56 in. inside diameter and $1\frac{3}{4}$ in. thick. The fuel used was gasoline, which was atomized in a tank arranged in accordance with the outline drawing shown in Fig. 1. The two tires were heated simultaneously, and the time required for removal was 12 minutes in one instance, and 16 minutes in the other. The amount of gasoline consumed was 4.42 gallons.

The tires were of course light, in comparison with new ones, and the wheels being from under the engine, no obstacle was afforded to driving them off, hence not so thorough a heating was required than would be the case were the wheels in their proper position. In this latter instance the heating must necessarily be such to allow of their being pulled off the centers by a tire hook. The time required to heat two such tires simultaneously, with a burner for each, is in the neighborhood of 40 minutes. The probable consumption of gasoline during the period may be closely approximated by reference to the figures obtained in the test first mentioned simply by averaging the amount of. gasoline used per minute, and multiplying by 40 minutes, the result being 12.6 gallons for the assumed case of 40 minutes.

It impressed the writer that the amount of gasoline used was highly excessive, and induced some reflection on how the heavy loss which ensues in the universal practice of heating tires might be overcome at least in part. To burn one pound of gasoline requires about 3.36 pounds of oxygen, which means that 14.6 pounds of air must be used to obtain this amount of oxygen. The products of combustion are practically 3 pounds of carbon dioxide, 1.35 pounds of steam and 11.25 pounds of nitrogen which was contained in the air. The specific heat of carbon dioxide is 0.217, so to raise the temperature of the three pounds one degree requires 0.651 b.t.u. The specific heat of superheated steam is about 0.5, and to raise the temperature of the 1.35 pounds one degree 0.675 b.t.u. are necessary. Nitrogen has a specific heat of 0.244, therefore to raise the 11.25 pounds one degree in temperature 2.745 b.t.u. will be consumed. This means that 4.07 b.t.u. will be absorbed in raising the product of combustion one degree, provided that none of the heat is lost through radiation.

In burning one pound of gasoline there is liberated about 20,000 heat units; consequently the theoretical temperature of the products of combustion will be $20.000 \div 4.07 = 5{,}000$ degrees, but it is a well-known fact that no such temperature is attained in practice, because much of the heat is lost through radiation. Assuming that the temperature, allowing for the radiation of the heat from the flame, is 4,000 above that of the atmosphere, then there will be four-fifths of the liberated heat available for heating the tires; in other words, about 16,000 heat units. All of this is not, of course, available, because if all the heat were taken out of the flame the latter must cease to exist. Assuming that 100 degrees temperature is sufficient to sustain the ignition after once established, there is then available a net temperature for heating the tires $4000 - 100 = 3900$, and, roughly speaking, 15,600 heat units.

It is positive that the tires had not attained any such temperature, as the melting point of steel is but 2,500 degrees. From the writer's observations the temperature was not more

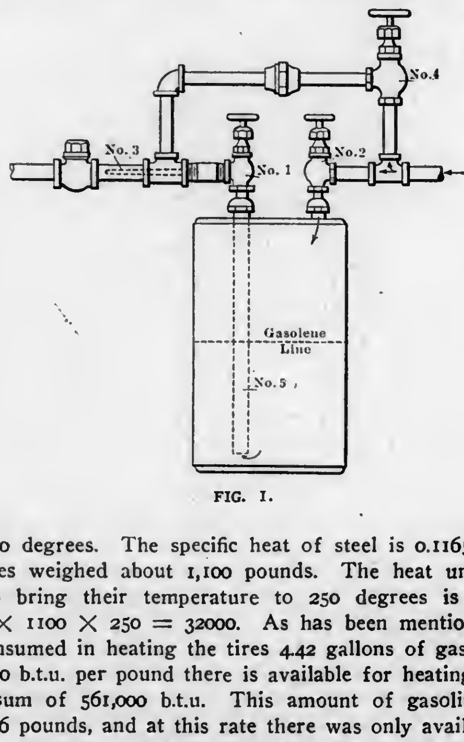


FIG. 1.

than 250 degrees. The specific heat of steel is 0.1165, and the two tires weighed about 1,100 pounds. The heat units necessary to bring their temperature to 250 degrees is therefore $0.1165 \times 1100 \times 250 = 32000$. As has been mentioned, there was consumed in heating the tires 4.42 gallons of gasoline, and at 15.600 b.t.u. per pound there is available for heating the tires a net sum of 561,000 b.t.u. This amount of gasoline weighs about 36 pounds, and at this rate there was only available some 6 per cent. of the net heat available for heating the tires. The question then must arise, where did the balance go?

The writer is of the opinion that much of this loss can be satisfactorily accounted for. Referring to Fig. 1, the compressed air enters the tank through globe valve No. 2, expands, and gives up its heat arising therefrom to the walls of the tank, the latter in turn radiating it to the shop atmosphere. In such

a manner refrigeration is, of course, taking place to a small extent. The purely cold liquid is forced by the air pressure above it through pipe No. 5, through needle valve No. 1 and nozzle No. 3 to the burner. On its way to the burner after leaving the nozzle the liquid gasoline is picked up by the gusts of compresed air from the by-pass which comes through valve No. 4, and the gasoline becomes still further refrigerated, as here the compressed air expands from a pressure of about 100 pounds to practically that of the atmosphere, and the absorbtion of heat must be considerable.

During this process the gasoline has not been vaporized, but merely dispersed into globules through the fanning action of the refrigerated air. When this mixture of globules and air

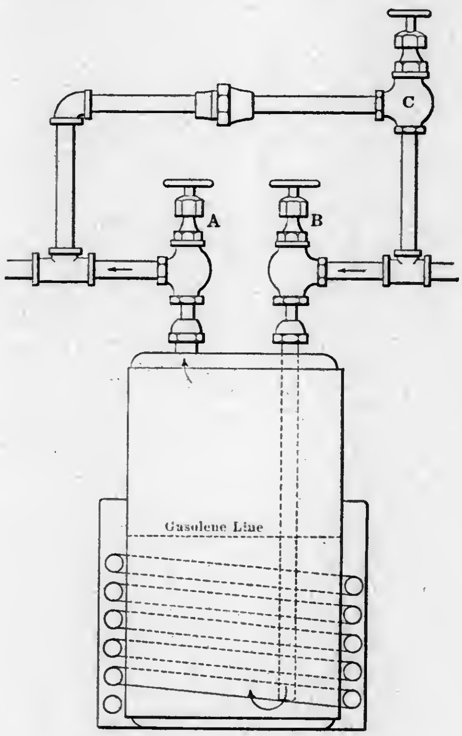


FIG. 2.

reach the burner, the globules which happen to be small enough will ignite, but the larger ones are checked by the walls of the burner to run out on the floor, where part soaks into the wood or earth and the others evaporate or become ignited. This, and the radiation of heat, are the main sources of loss, but the former is by far the greater.

The loss of the liquid gasoline can be overcome entirely by arranging the heating apparatus as shown in Fig. 2. Instead of the compressed air coming in on top of the gasoline it should be *vice versa,* entering through the valve (B) to the pipe, which extends very close to the bottom, and bubbling up through the liquid. The tank should have a coil of pipe and the coil jacketed so that when steam is allowed to circulate in the coil heat will not radiate into the shop atmosphere. Then, as the air would bubble up through the liquid gasoline and excelsior, the former would become broken up into globules, and finally vaporized, on account of a temperature being maintained at which gasoline best vaporizes. There would be no solid globules left to be carried to the burner only to run out of it unconsumed, as has been mentioned. To overcome the loss from radiation is a more complicated question and it must be principally taken care of in the design of the burner; one of such design that the flame will be enclosed and kept always impinging upon the tire surface.

The loss in money per annum to a railroad having, say, 1,500 locomotives, is worthy of serious consideration in the general question of tire heating. The shop with which the writer is connected takes care of about 300 locomotives per year and removes and applies approximately 900 tires. This is but one-fifth of the engines, and consequently the same proportion of tires handled on the entire railroad, which would be in the vicinity of 4,500 tires heated twice, this double treatment bringing the heating up to 9,000 tires. As the statement has been made that but 6 per cent. of the available heat has been realized, then 94 per cent. is accordingly wasted. If 50 per cent. of this loss can be recovered the proposition becomes endowed with much importance. Since it required 4.42 gallons of gasoline to remove the tires under test in an average of 14 minutes each, the portion used was 0.31 gallons. The average time, however, for such removal with the wheels under the engine must be set a minimum of 30 minutes, which would bring the total consumption to 9.3 gallons for heating two tires, or 4.6 gallons per tire.

Forty-five hundred tires heated twice in each year is equivalent to 9,000, which multiplied by 4.6, equals 41,400 gallons of gasoline wasted, which positively could be saved, as it will be recalled that the writer is taking only 50 per cent. of the calculated loss. This means in money, if gasoline can be bought for 13 cents per gallon, no less than $5,382. The writer believes that it would be worth while to delegate a man at a fair salary to devote his entire time to this matter until straightened out. There is no question but that intelligent inquiry and co-operation with the shop forces would bring about a reduction in cost so great as to be surprising.

STAMPING DATES ON CROSS TIES.—The Lehigh Valley Railroad has adopted a plan for recording the age of every new cross tie on the system. This will enable the company to determine, with mathematical accuracy, the relative efficiency of the different woods and the value of the creosote preservation treatment. It is done in this way: First, the dating nails are manufactured with the proper numerals on the heads, indicating the year; for example, "11," meaning the year 1911. Then one of these nails is driven into each new tie as it is laid on the track. Thus in the future the maintenance of way experts will be able, upon the replacement of a tie, to know just how long it has lasted.

THE MODERN GEAR WHEEL represents the latest refinements in the application of geometry to mechanics, and the study of the proper curves for tooth profiles has been supplemented by the production of highly organized machine tools for the precise reproduction of these forms in the actual teeth of the wheel. It is often overlooked, however, that, under the demands of modern intensified manufacturing operations, the wear upon such teeth will make such modifications in their form that, unless the material is of the most resistant character, these curves, so carefully studied and so accurately reproduced, will be gone long before the operative life of the wheel is over.

IT IS ESTIMATED THAT OIL AS LOCOMOTIVE FUEL is rapidly on the increase. Statistics show that the consumption of fuel oil on the roads in 1909 amounted to 19,939,394 barrels, an increase of about 18 per cent. (3,050,324 barrels) over 1908. Oil as fuel has several good points in its favor over coal; besides being easier to use in the firebox it also does away largely with the smoke nuisance, danger from sparks, etc.

THE ORDINANCE REQUIRING RAILROADS within the city limits to adopt electric motive power, came before the city council of Chicago for action on Monday evening, March 6. After heated discussions for and against the ordinance the matter was referred to the council committee on local transportation and a series of public hearings arranged for.

THE TOTAL LENGTH OF THE RUNNING TRACK of the railways of the United Kingdom at the end of 1909 was 39,622 miles, and the total length of sidings was 14,350 miles. At the end of 1908 the length of running track was 39,316 miles.

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CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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CONTENTS

THE INFLUENCE OF CLEANLINESS AND ORNAMENT

Everybody has heard that cleanliness is next to godliness. It is certainly true that cleanliness has a potent influence on those who come within the circle of its spell. Practiced in daily life, it breeds self-respect and commands the respect of others; practiced in the shop and on the engine, it prompts care and economy in the performance of work, and practiced in the office it expedites business and adds a tone of respectability to the plainest furnishings. The transition from cleanliness to ornament is an evolutionary step that under proper conditions and within reasonable limits gives tone to the good influences of cleanliness. In this and some other ways ornament may prove useful and valuable. The popular love of ornament is shown in nearly every home where means permit, and its refining influence is attested by the fact that in the homes of the most cultured special consideration is given to it.

All are familiar with the importance given to ornament in passenger car construction, especially private, parlor and sleeping cars. Much has been said about the over-ornamentation of cars, and doubtless extremes have been reached, but the attention given the matter has not been without reason. Those who have to deal with passengers know that this feature is so pleasing to them that once employed it is required. Cabooses are sometimes tastefully ornamentad by the crews belonging to them. The influence is good, and probably causes more zealous flagging by the rear brakeman while on the road, and less hours spent by the crew about saloons while at terminals.

The interiors of shops do not offer inviting opportunities for ornamentation, but very frequently the yards about the shop do. A few strips of greensward and a few beds of flowers tastefully arranged make a vast improvement in the appearance of an otherwise clean but barren looking space. The effect of such a change is not lost on workmen, for love of the beautiful is human, and nothing can be lost by making a place of work attractive. It is gratifying to note that after an unwarranted lapse of many years such decoration of railroad shop and station grounds is again becoming popular, and doubtless the time will come when its advantages will be much more apparent.

The influence of cleanliness on shop and engine men encourages careful habits which result in efficient and economical work; it encourages and facilitates the inspection of cars, and especially locomotives, which leads to economy in repair and fewer failures on the road, and the influence of ornament, where judiciously applied, is pleasing and elevating, and encourages and confirms careful habits.

OIL VERSUS GREASE LUBRICATION

The recent action of a prominent Eastern railroad in reverting to the use of engine oil for pin and journal lubrication, after two or three years' practically exclusive employment of grease, constitutes a move of general interest in view of the fact that the latter compound has become so generally adopted in every branch of locomotive service, and has proved so largely exempt from complaint or criticism. In the specific case to which reference is made there was no fault to find with the grease failing in its appropriate business as a lubricant, as the records of the motive power department in question are said to indicate a decreased number of hot bearings over the period when oil was in universal use, but there is another and somewhat unlooked for reason advanced for its abandonment.

The latter is found to be the increased wear of bearings under grease lubrication, and it is said that this condition reached proportions which could not be defined other than startling. One crank pin showed a wear between shoppings of 3/16 in. on grease, and a reduction of ⅛ in. in the nominal diameter of these parts was not uncommon. It was in fact the returns from the various repair shops indicating an abnormally large number of crank pin renewals which first attracted attention to the matter,

and resulted in the inauguration of a thorough and systematic inquiry. This latter brought to light a similar condition in driving journals, and by subsequent tests, in which one side of an engine was run on oil and the other side on grease, it was satisfactorily demonstrated that the proportion of wear was vastly in excess where the latter was in use. Thereupon the gradual return to oil was made until at this writing it has no doubt entirely supplanted its competitor.

While this investigation is of unquestioned interest it is still a matter of doubt in our mind as to whether it will be generally accepted as conclusive. Even admitting the accuracy of the information at hand the question naturally arises if it would not be better to countenance this wear in view of the admitted results in decreased engine failures which have followed the introduction of grease? The profusion of hot boxes which previously attended the use of oil in heavy service, arising largely from inattention and improper packing, were attended by a full quota of scored journals, and we feel safe in asserting that much more metal has perforce been turned off to straighten these up than was ever worn away by grease impact.

The fact that the driving box lubricator takes care of itself, maintaining a constant and uniform contact with the journal, and requiring no attention other than refilling at periodic intervals establishes points of superiority in its favor over the old arrangement that will prove very difficult to offset. It should also be recalled in this connection that the underneath arrangement of the modern locomotive is necessarily complicated, and its driving box cellars in many instances are largely inaccessible, without a great deal of work, to the frequent repacking which appears to be demanded where waste cellars are used. A contrivance, therefore, becomes a necessity which will limit this operation to the longest period of time, and this is attained in the grease cellar, which is another strong point in its favor.

In view of the length of time which grease 'ubrication has been in vogue it seems rather surprising that a similar criticism regarding wear has not materialized in some quarter heretofore, but no such instance can be recalled, and it does not seem to appear anywhere as a matter of record. It appeals to us, all things considered, that it would be far more to the point to contend with the increased wear, while making every effort to minimize it, than to return to the unpleasant conditions of former times. We all know that box packing was a very much slighted and actually abused proposition of the old days, and that the welcome advent of the driving box lubricator cleared up a general situation which might well be termed as distressing.

AUTOMATIC STOKERS

It has been reported a number of times in the past that a successful locomotive stoker had finally been designed, but a year or so later it has been found that it is still in the experimental stage, and finally it has practically disappeared from view. This is not meant to reflect in any way on the reporters, since there is no doubt that there have been several automatic stoker designs which would successfully maintain the steam pressure of the locomotive under very severe conditions, and from this standpoint they have been successful, but experience has clearly shown that the mere ability to distribute large amounts of coal in proper form to be burned and thus maintain steam pressure, does not constitute a success, although, of course, it is an essential feature of a successful machine of this kind. A really successful stoker, however, must, in addition to this, be reliable to the last degree. If it is not capable of operating continuously with a reliability at least equal to that of the air pump it cannot be considered an entire success. Further, it must be rugged enough to do this without any unusual attention in the roundhouse. No doubt when stokers come into more general use it will be found advisable to organize a small force in the roundhouse for their inspection and repair, practically the same as is now maintained for air brakes. While it can hardly be expected at the start, the successful stoker must finally prove itself to be in the same class with the air brakes and injectors and should be treated in the same manner at terminals.

Fuel economy is by no means an essential feature of the successful locomotive stoker. There will probably be no stoker designed which will be capable of equaling the economy of the very best hand firing, but they should, and in fact are at present doing better than the average hand firing in this respect. There are attractive prospects in the possibility of using a grade of fuel which cannot generally be fired successfully by hand, and along this line considerable economy can be expected. The ability to handle quantities of coal beyond the limits of hand firing will, of course, be demanded of the automatic stoker, and while it is desirable to burn this as economically as possible, the first essential is to burn it and maintain the steam pressure. An increase in the "horse power of the fireman" is the constantly increasing demand of present conditions.

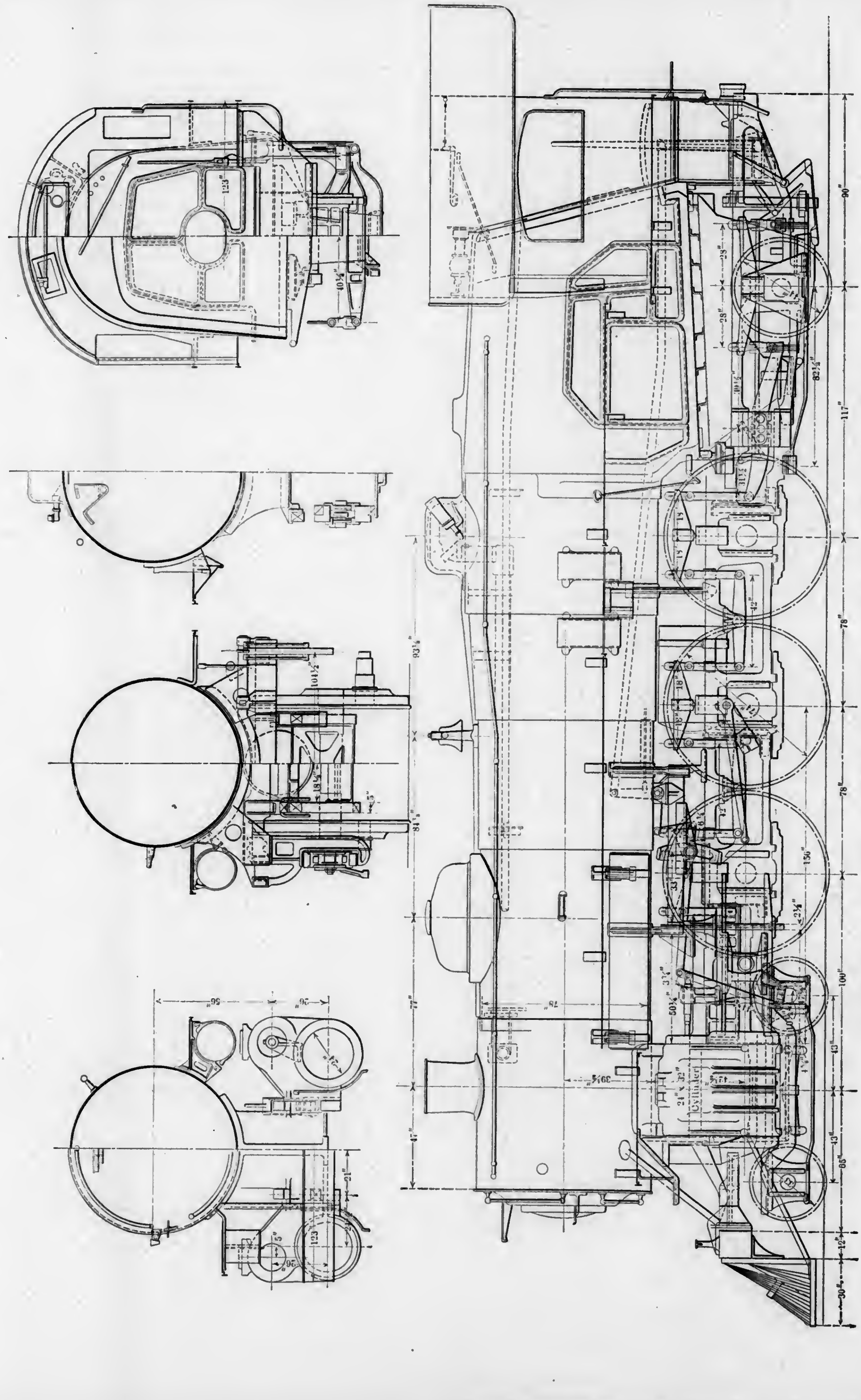
THE NEGLECTED BOILER SHOP

It is a rather singular fact that the development of the boiler shop has not been in keeping with its activity so characteristic in connection with other departments, and in many quarters a crying need for reform is strictly in order. Boiler shops can be found on roads even of considerable size that are equipped in a very inferior manner. Some of these are shops merely in name, and it is really astonishing that the repair work can be kept up at all with the limited facilities at hand. For instance, they may have but one power machine, and that of only moderate size, for punching and shearing; one or two drill presses in doubtful order, and one or two small bending rolls, together with the forges, etc.

This is a very inferior equipment for a boiler shop in which to handle any railroad work, even if nothing but repairs are done. It is impossible to do all the repairs in such a shop that may be necessary; or, at least, not possible to do them in an economical manner. On the other hand, an equipment sufficient to handle a fair amount of work at an economical figure should be supplied with tools somewhat as follows: A hydraulic riveting machine, if much new work is to be done, a large power punching machine, a large power shearing machine, large power plate bending rolls, a tube sheet boring machine, a power flue-welder, drill presses, small shears, forges, etc. In other words, the boiler shop should be placed on an equal footing with the others, and it needs a mere glance through about half of the locomotive terminals in this country to make it plain that it is not.

No sufficient reason can be assigned for this neglect, and it certainly is one which costs money in labor arising from slow operations. We have in mind on a large eastern railroad, a shop not a great way from New York, where flues are swaged down for ferrules by driving a die on the end by sledges. It requires three days' work for two men to so treat, say, 335 flues composing a set, where they might be done at the rate of one per minute by the application of suitable dies to a welding machine.

In regard to the small tools for boiler shop use, such as drills, reamers, taps, punches, chisels, etc., there should be an ample supply in every shop. They should be kept in systematic order in a tool room adjoining the boiler shop, and with strict regulations in regard to their use and return to the tool room. They should not be located in the general tool room which is generally a part of, or an annex to, the machine shop, where a walk of half a mile becomes in order to get them, with, of course, the accompanying feature of so much lost time. Although the fact may have largely escaped notice, it is not very difficult to criticise boiler shop facilities in general, and it is now about time that this important department be accorded the attention to which it is entitled, and which is so liberally bestowed on other shops possibly far less vital to the success of the general scheme.



NEW DESIGN OF POWERFUL PASSENGER LOCOMOTIVE ON THE BALTIMORE AND OHIO RAILROAD.

Powerful Freight and Passenger Locomotives

THE BALDWIN LOCOMOTIVE WORKS HAS RECENTLY DELIVERED FORTY FREIGHT LOCOMOTIVES AND TEN PASSENGER LOCOMOTIVES TO THE BALTIMORE & OHIO RAILROAD, WHICH ARE EXCEPTIONAL IN THE NUMBER OF PARTS THAT ARE COMMON TO BOTH DESIGNS.

Take a very large and powerful Pacific type locomotive designed for the heaviest class of high speed traffic and remove the driving and truck wheels, the main and front frames, rods and valve gear. Press off the wheels and replace them with centers 10 in. less in diameter, provide another pair of driving wheels of the same kind, and new main and front frames with four pedestals instead of three, provide a two-wheel engine truck, new rods, equalizers and valve gear to suit, using the same driving boxes, shoes and wedges and springs, as far as they will go, providing the duplicates for the extra wheel, and you have a locomotive of the Mikado type which will be found to be thoroughly satisfactory as a powerful freight locomotive.

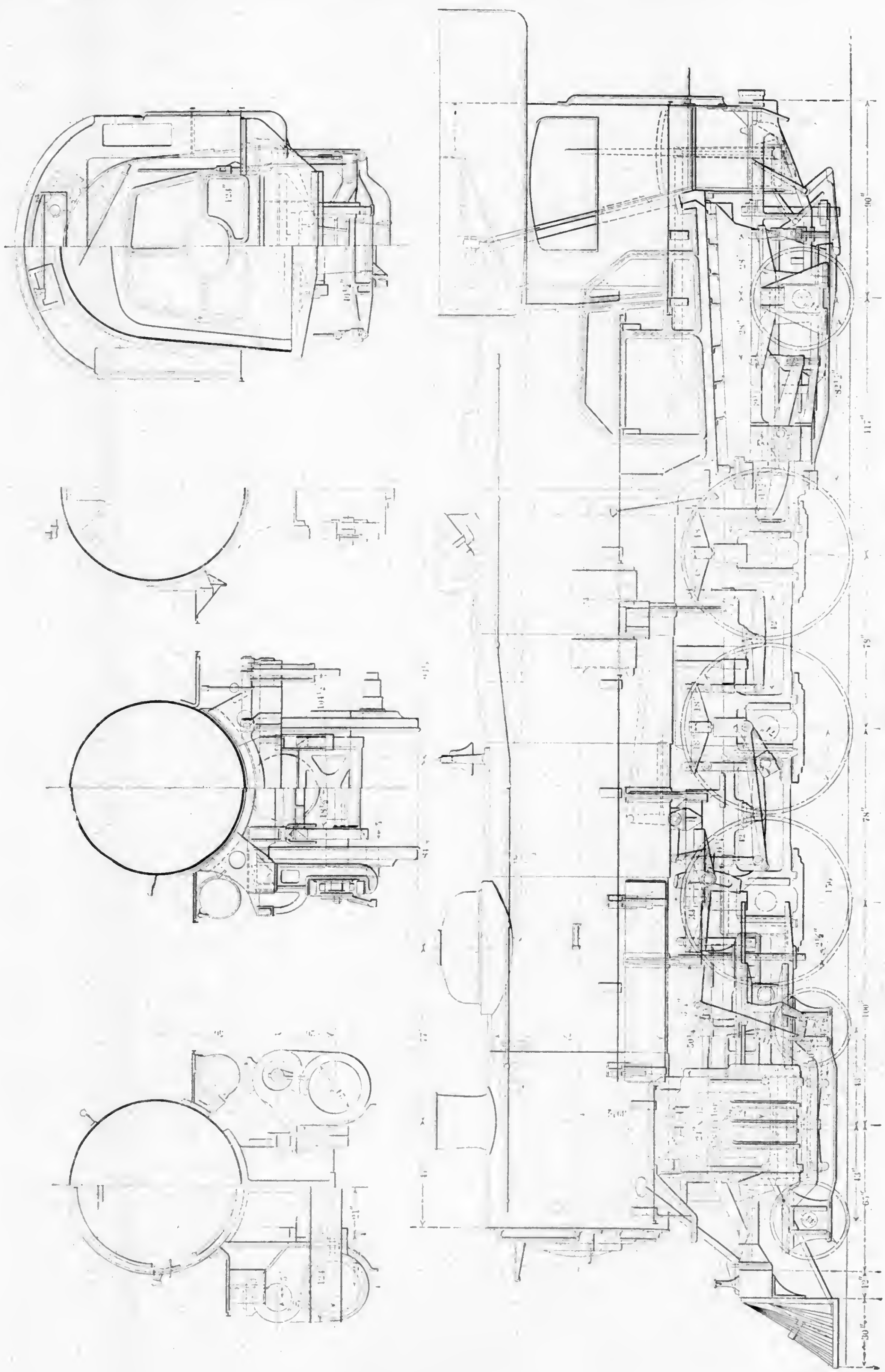
This practically is what the Baltimore & Ohio Railroad has done in a recent order of 50 locomotives, of which ten are Pacific types and 40 Mikado types. On the two classes the boilers, cylinders, cabs, trailer truck, piston rods and cross head, valves, all boiler and firebox attachments and parts are in duplicate. This duplication extends even to springs, driving boxes, shoes and wedges, frame cross ties, cab fittings and tenders. Many of these parts are of course also standard to other locomotives already in service, making the advantage of interchangeability even greater. A study of the two designs, as shown by the general specifications at the end of this article, indicate that both classes are entirely suited for the service to be performed.

The passenger locomotives are among the largest of the Pacific type ever built. They have 24 by 32 in. cylinders, a steam pressure of 205 lbs. and with 74 in. drivers develop a tractive effort of 43,400 lbs. The total weight is 263,800 lbs., placing them among the heaviest of this type ever constructed. The Mikado type, with 64 in. drivers, the same cylinders and steam pressure, gives a tractive effort of 50,200 lbs. and weighs 274,600 lbs., being the heaviest of the type on our records.

Under present conditions it makes no difference whether a locomotive is in freight or passenger service, it is the steam making capacity that is the most vital feature in determining the success of the design. There is no reason why a boiler that is suited for a high speed heavy service Pacific type, which it is fair to assume will be of the maximum evaporative capacity possible for the weight, will not be equally well suited to a moderate speed freight locomotive. In this case the boilers are 78 in. in diameter, of the extended wagon top type and have 389 2¼ in. tubes, 21 ft. in length. This gives a tube heating surface of 4,789 sq. ft., or altogether with 228 sq. ft. in the firebox gives a total of 5,017 sq. ft., or 300 sq. ft. of heating surface for each cubic foot of cylinder volume. While this ratio is not as large as is sometimes provided for Pacific type locomotives it is larger than is customary on freight engines and is well within good practice for passenger service. The boilers are well designed along conservative lines and contain few novelties. Surge plates have been placed in the boiler barrel at the water level, one immediately in front of the firebox and the other about 7 ft. back of the front tube sheet. The injectors, as is the practice on this system, are placed on the back head and discharge into an internal pipe, which delivers the feed water near

PACIFIC TYPE LOCOMOTIVE HAVING MANY DUPLICATE PARTS WITH THE MIKADO TYPE SHOWN BELOW

MIKADO TYPE LOCOMOTIVE HAVING SAME BOILER, CYLINDERS, TRAILER, DRIVING BOXES, SPRINGS, CAB AND MANY OTHER PARTS AS PACIFIC TYPE SHOWN ABOVE.



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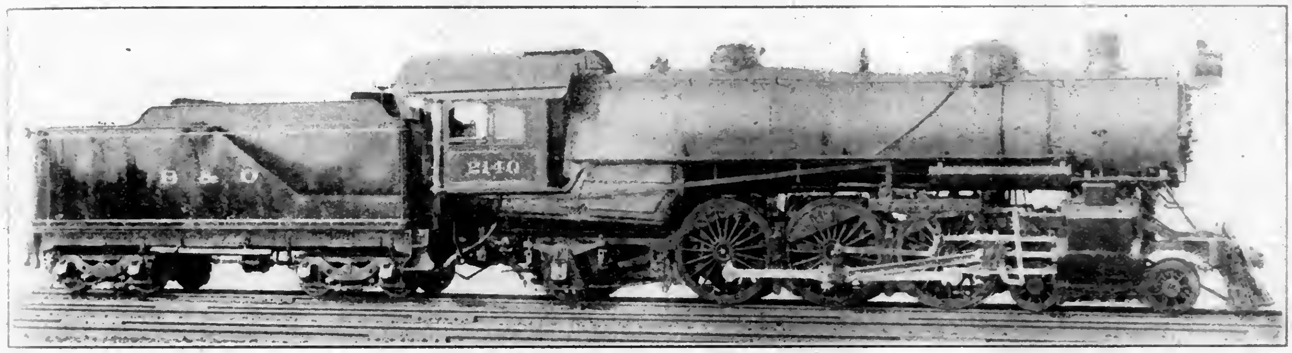

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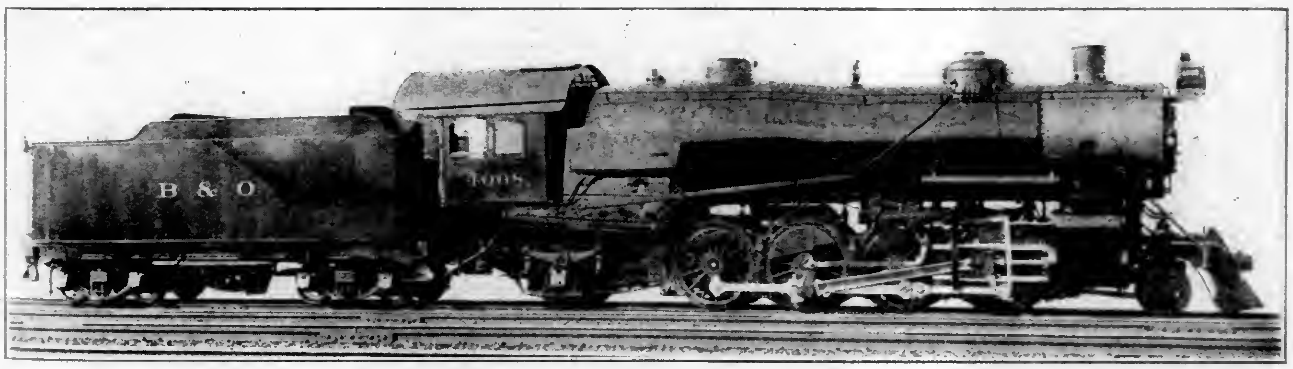

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the front end of the barrel. The mud rings are 5 in. in width on all sides, and the water legs have a very slight increase in width as they rise, both sheets, however, being inclined inward from the mud ring. Inside admission piston valves, 14 in. in diameter, are provided, the centers located 5 in. outside of the cylinder centers. The cylinders are cast in pairs with the saddle in the customary manner and are arranged for double front frames, the rails being 5 in. in width, the fastening being made by 1¼ in. bolts. They are keyed to the frames at the front only.

Nothing unusual is provided in the frame construction. The main and trailer frames are separate, the former being 5 in. in width and the latter 3½ in. Rigid vertical cast steel braces are provided at the main and rear pedestals and a lighter frame brace at the front pedestals in both types.

The Hodges type trailer truck with outside journals is used on both engines, the design being in duplicate. The feature of this truck as used in the present instance is a centering spring consisting of eight plates each 4 in. by ⅜ in. placed in a vertical position and secured in the center to a frame casting at the top and by a clamp to the trailer truck frame at the bottom.

The general dimensions of both designs are given in the following table:

GENERAL DATA.		
Type	4-6-2	2-8-2
Gauge	4 ft. 8½ in.	
Service	Pass.	Freight
Fuel	Bit. Coal	
Tractive effort	43,400 lbs.	50,200 lbs.
Weight in working order	263,800 lbs.	274,600 lbs.
Weight on drivers	166,200 lbs.	219,000 lbs.
Weight on leading truck	52,400 lbs.	19,500 lbs.
Weight on trailing truck	45,200 lbs.	36,100 lbs.
Wt. of engine and tender in working order	440,000 lbs.	450,000 lbs.
Wheel base, driving	13 ft.	16 ft. 9 in.
Wheel base, total	34 ft. 8 in.	35 ft.
Wheel base, engine and tender	70 ft. 10⅝ in.	71 ft. 2⅜ in.
RATIOS.		
Weight on drivers ÷ tractive effort	3.83	4.37
Total weight ÷ tractive effort	6.08	5.47
Tractive effort × diam. drivers ÷ heating surface	641.00	641.00
Total heating surface ÷ grate area	71.80	71.80
Firebox heating surface ÷ total heating surface, %	4.56	4.56
Weight on drivers ÷ total heating surface	33.10	43.80
Total weight ÷ total heating surface	52.60	54.80
Volume both cylinders, cu. ft.	16.80	16.80
Total heating surface ÷ vol. cylinders	300.00	300.00
Grate area ÷ vol. cylinders	4.17	4.17
CYLINDERS.		
Kind	Simple	
Diameter and stroke	24 x 32 in.	
VALVES.		
Kind	Piston	
Diameter	14 in.	
WHEELS.		
Driving diameter over tires	74 in.	64 in.
Driving thickness of tires	4 in.	4 in.
Driving journals, main, diameter and length	11 x 13 in.	11 x 13 in.
Driving journals others diameter and length	9½ x 13 in.	9½ x 13 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ x 12 in.	6 x 10 in.
Trailing truck wheels, diameter	44 in.	44 in.
Trailing truck, journals	8 x 14 in.	8 x 14 in.
BOILER.		
Style	Ext. W. T.	
Working pressure	205 lbs.	
Outside diameter of first ring	78 in.	
Firebox, length and width	120 x 84 in.	
Firebox plates, thickness	⅜ & ½ in.	
Firebox, water space	5 in.	
Tubes, number and outside diameter	389—2¼ in.	
Tubes, length	21 ft.	
Heating surface, tubes	4,789 sq. ft.	
Heating surface, firebox	228 sq. ft.	
Heating surface, total	5,017 sq. ft.	
Grate area	70 sq. ft.	
TENDER.		
Frame	15 & 10 in. chan.	
Wheels, diameter	36 in.	33 in.
Journals, diameter and length	6 x 11 in.	
Water capacity	9,500 gals.	
Coal capacity	16 tons	

To Provide Additional Facilities for handling traffic on its Indianapolis Division, the Pennsylvania Lines are making extensive improvements by constructing 25.9 miles of second track. Some idea of the magnitude of the work which has been undertaken is seen in the figures showing that no less than twenty-five street and highway and two railroad grade crossings are to be eliminated. This alone will entail the building of four overhead and sixteen undergrade crossings and the vacation of five highways, formerly crossing the railroad at grade.

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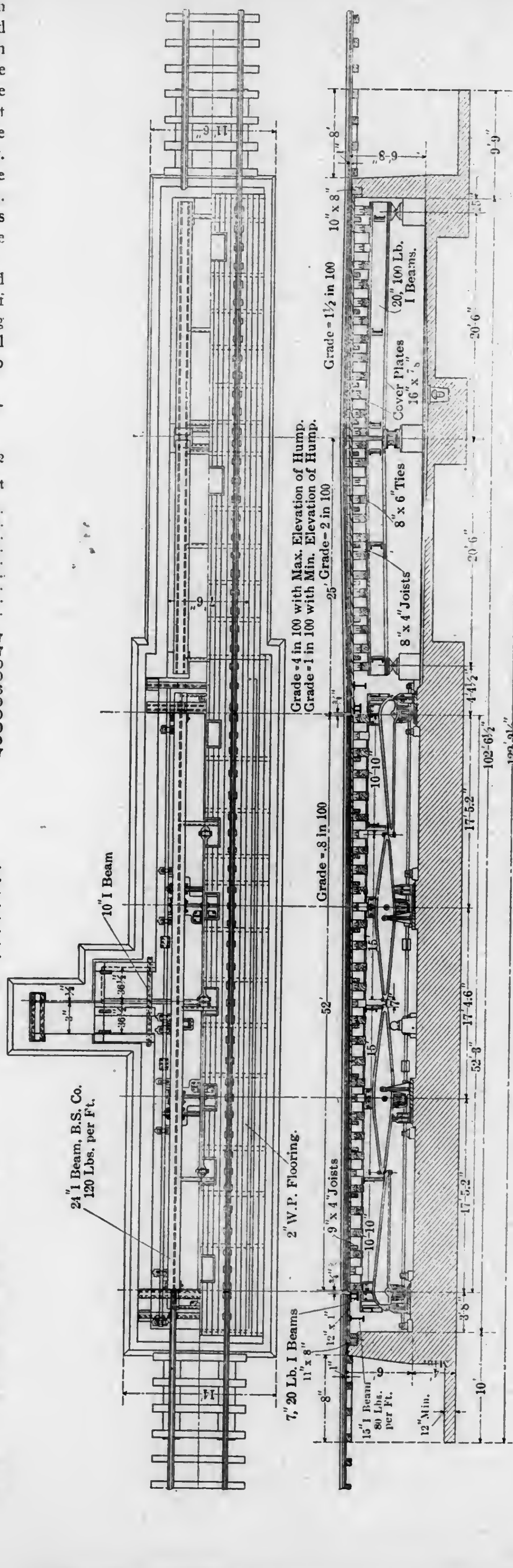


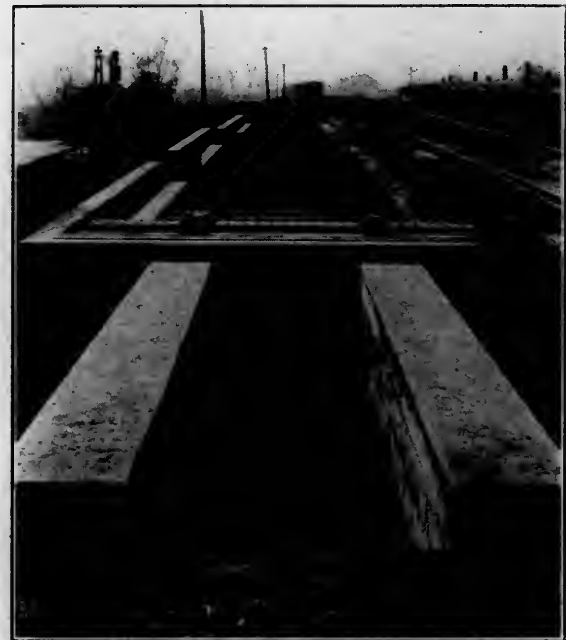
FIFTY-TWO FOOT TRACK SCALES WITH MECHANICAL HUMP—PENNSYLVANIA RAILROAD.

A NEW DESIGN 52-FOOT TRACK SCALE WITH MECHANICAL HUMP.

PENNSYLVANIA RAILROAD.

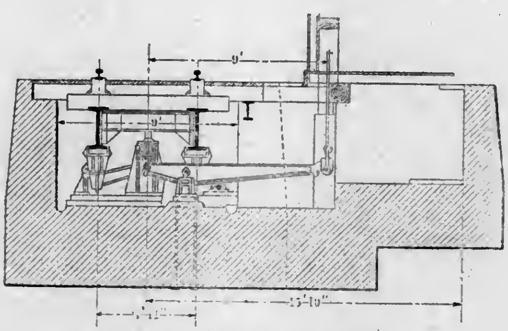
At West Brownsville Junction, Pa., the Pennsylvania Railroad have recently built a new 52-foot track scale which incorporates a number of important improvements and interesting details. With the scale has also been constructed a mechanical hump, which, for a distance of 25 ft. from one end of the scale platform, can be given an inclination varying between 1 and 4 per cent. grade as desired. This scale is provided with a mechanical relieving gear, doing away with the customary dead track, and is arranged so that the platform is independent of the weighing mechanism, thus eliminating the effect of snow and ice, wind pressure, or dirt on the empty balance of the scale.

It will be noticed by reference to the illustration that all wooden substructure has been eliminated and a most substantial



VIEW SHOWING SUBSTANTIAL FOUNDATIONS.

concrete foundation is provided for all parts. Tipping of the platform and the overhang at the ends have been avoided and all vital parts of the mechanism are easily accessible. It is of the four-section type, since with this arrangement there are no idle connecting levers required with their additional fulcrum points and friction. A new type of main bearing has been employed, which gives greater freedom of action to the weighing platform and eliminates the gyration of the knife edges across the face of the hardened steel. These bearings are of the suspension type, wherein two links, suspended from the main lever knife points, support a yoke casting bolted to the eye-beams



CROSS SECTION OF FIFTH LEVER.

forming the bridge tnat supports the scale rails. All of the main lever stands and extension lever stands supported from the four main bed plates are provided with self-compensating

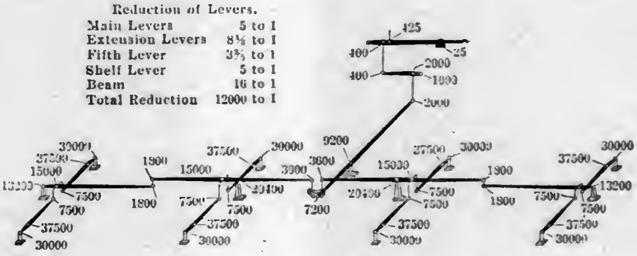
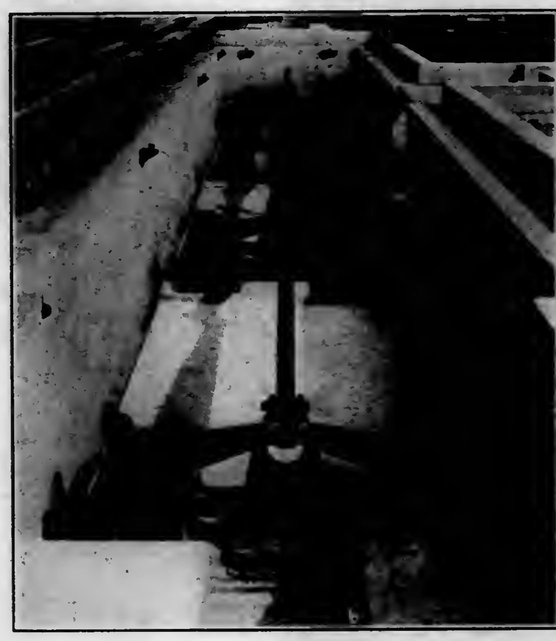


Diagram showing Loads on Lever System.

steels wherever a pivot contact is made and means are provided for maintaining an independent alignment of each knife lever. Leveling pads are also provided on all levers with faces machined in the same plane with the neutral axis.

A maximum load of about 4,000 lbs. is provided for each lineal inch of knife edge at any point. All of the friction as well as contact points throughout the scale are made of a special mixture of vanadium steel which, it is believed, will be less susceptible to corrosion and will give a longer life.

Probably the most radical departure from the usual form of construction is the introduction of relieving gear, which takes the place of the usual rigid dead rail system with supporting columns that practically fill the vault and prevent proper inspection and maintenance of the bearings. It also eliminates the approach and switches at either end. This relieving gear



VIEW SHOWING LEVERS AND RELIEVING GEAR IN PLACE.

consists of a series of eight toggle lever jacks supported in pairs by the universal bed plates. These jacks are operated through suitable link connections from a shaft which in turn is operated by a double-ended cylinder, using either air or water for power, the controlling valves being in the scale office. The mechanism can also be operated by hand if necessary. When these jacks are put in operation they raise the platform to a position of repose, taking all weight from the knife edges, but do not lift the knife edges from their seats. There is a semaphore at either end of the scale connected to the bearing shaft, which indicate whether the scale is out or in. While these jacks will support the largest consolidation locomotives without showing any weight on the beam while it is going over the scale, the relieving gear cannot be operated while the scale is under load, but since the aver-

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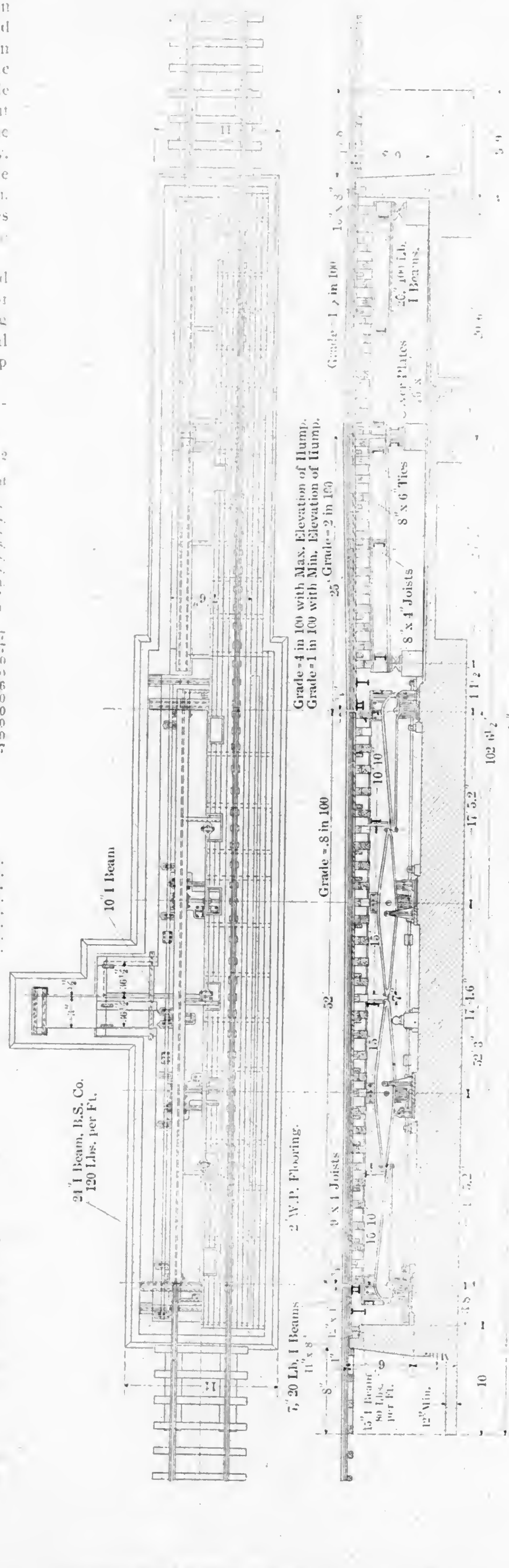
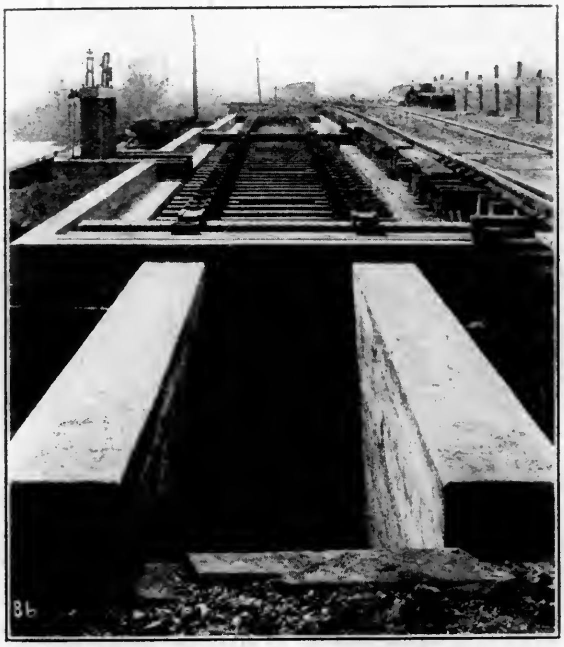


FIFTY-TWO FOOT TRACK SCALES WITH MECHANICAL HUMP—PENNSYLVANIA RAILROAD.

A NEW DESIGN 52-FOOT TRACK SCALE WITH MECHANICAL HUMP.

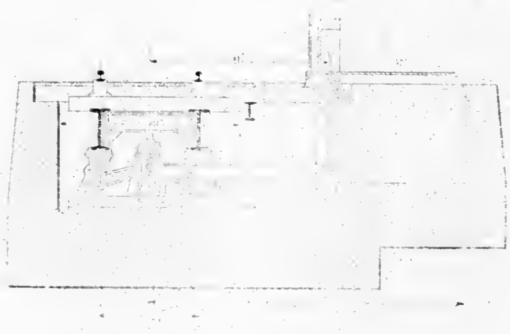
PENNSYLVANIA RAILROAD

At West Brownsville Junction, Pa., the Pennsylvania Railroad have recently built a new 52-foot track scale which incorporates a number of important improvements and interesting details. With the scale has also been constructed a mechanical hump, which, for a distance of 25 ft. from one end of the scale platform, can be given an inclination varying between 1 and 4 per cent. grade as desired. This scale is provided with a mechanical relieving gear, doing away with the customary dead track, and is arranged so that the platform is independent of the weighing mechanism, thus eliminating the effect of snow and ice, wind pressure, or dirt on the empty balance of the scale. It will be noticed by reference to the illustration that all wooden substructure has been eliminated and a most substantial



VIEW SHOWING SUBSTANTIAL FOUNDATIONS.

concrete foundation is provided for all parts. Tipping of the platform and the overhang at the ends have been avoided and all vital parts of the mechanism are easily accessible. It is of the four-section type, since with this arrangement there are no idle connecting levers required with their additional fulcrum points and friction. A new type of main bearing has been employed, which gives greater freedom of action to the weighing platform and eliminates the gyration of the knife edges across the face of the hardened steel. These bearings are of the suspension type, wherein two links, suspended from the main lever knife points, support a yoke casting bolted to the eye-beams



CROSS SECTION OF FIFTH LEVER.

forming the bridge that supports the scale rails. All of the main lever stands and extension lever stands supported from the four main bed plates are provided with self compensating

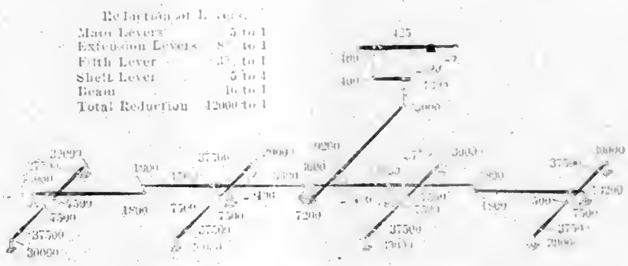
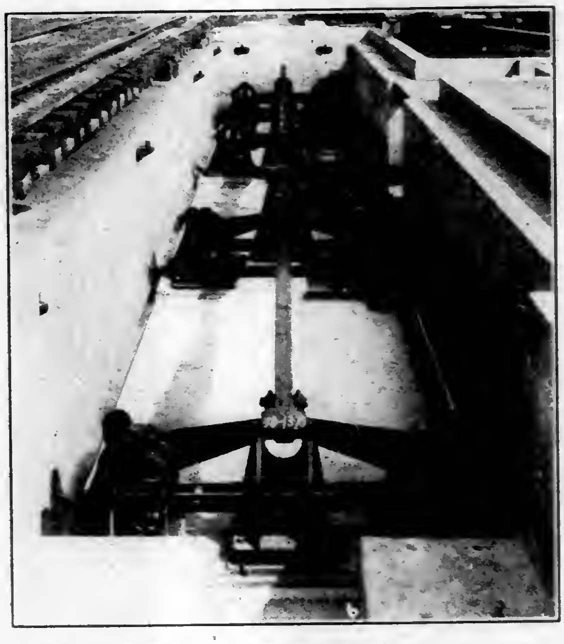


Diagram showing Loads on Lever System.

steels wherever a pivot contact is made and means are provided for maintaining an independent alignment of each knife lever. Leveling pads are also provided on all levers with faces machined in the same plane with the neutral axis.

A maximum load of about 4,000 lbs. is provided for each lineal inch of knife edge at any point. All of the friction as well as contact points throughout the scale are made of a special mixture of vanadium steel which, it is believed, will be less susceptible to corrosion and will give a longer life.

Probably the most radical departure from the usual form of construction is the introduction of relieving gear, which takes the place of the usual rigid dead rail system with supporting columns that practically fill the vault and prevent proper inspection and maintenance of the bearings. It also eliminates the approach and switches at either end. This relieving gear



VIEW SHOWING LEVERS AND RELIEVING GEAR IN PLACE.

consists of a series of eight toggle lever jacks supported in pairs by the universal bed plates. These jacks are operated through suitable link connections from a shaft which in turn is operated by a double-ended cylinder, using either air or water for power, the controlling valves being in the scale office. The mechanism can also be operated by hand if necessary. When these jacks are put in operation they raise the platform to a position of repose, taking all weight from the knife edges, but do not lift the knife edges from their seats. There is a semaphore at either end of the scale connected to the bearing shaft, which indicate whether the scale is out or in. While these jacks will support the largest consolidation locomotives without showing any weight on the beam while it is going over the scale, the relieving gear cannot be operated while the scale is under load, but since the aver-

age interval between cuts of cars is 18.6 seconds and the relieving gear can be operated in 1 second, it is not felt that this is necessary.

The object of the mechanical hump is to provide simple and effective means whereby, with a minimum of attendance for manipulating the cars, they can be passed rapidly and without stoppage over the platform to the scale with the proper velocity to permit each car to be weighed as it passes over the scale platform regardless of the variation in length of successive cars. For this purpose the 50 ft. of track just above the scale is supported in 25 ft. sections on large 20-in. I-beams, supported at the ends on pivotal castings and at the center by common rigid steel castings, one on either side, which in turn are supported by abutments to which the bed plates are bolted. These same

GEAR FOR ADJUSTING HEIGHT OF MECHANICAL HUMP.

abutments also support, directly under a vertical center line through the rail, two toggle lever jacks of the Sampson screw type, which are connected by an extension socket and are operated by a hand ratchet with a lever arm in the center. When the toggle jacks are set to give the required elevation, liners are inserted under the center castings and the jacks are relieved. Means are provided for taking care of the change in length of rail, due to a raised or lowered apex or to expansion or contraction from atmospheric conditions, by the insertion of bronze friction plates at the base of the four pivoted castings at either end of the hump, thus allowing them free change of position in a longitudinal direction.

The vault of both the scale and the hump are heated by a hot water circulating system and are provided with electric lights, permitting an easy and thorough inspection at any time.

Most of the features of this scale are covered by patents issued to A. W. Epwright, scale inspector of the Pennsylvania Railroad.

HIGH POWER LOCOMOTIVE HEADLIGHTS

During the past year considerable discussion has taken place in regard to the use of locomotive headlights of high candle-power. In seven states, Arkansas, Montana, North Carolina, Oklahoma, South Dakota, Texas and Washington, locomotive headlights of 1,500 candle-power or over are required by law; in Indiana, locomotive headlights of 1,500 candle-power or over are required by an order of the State railroad commission and in Georgia the law requires electric headlights with 300 watts at arc end reflectors 23 inches in diameter.

The ordinary oil headlight commonly employed on locomotives is seldom powerful enough or maintained in a condition to make it more than a marker to indicate to persons at stations or railway crossings, or in yards or to trains on other tracks, that an engine is approaching. As a means of discovering or identifying distant objects on the track it has practically no value. The argument in favor of the high-power headlight is that persons or obstructions on the track may be seen by the light of a powerful gas or electric headlight at a sufficient distance to enable the train to be stopped before reaching them. On straight track the high-power headlight undoubtedly affords a degree of illumination, except in snow or fog, sufficient to enable an experienced engineman to distinguish unusual objects on the track at a considerable distance.

As headlights are usually fixed in position, their rays are projected in the direction of the axis of the locomotive, and hence on curves do not illuminate the track ahead. Various devices have been submitted to the board intended to impart to the headlight, while the engine is rounding a curve, motion to turn its beam so that it will fall on the track. Most of these devices are crude, and attempt to use the curving of the front truck of the locomotive as it passes around curved track to rotate the headlight. It seems unlikely that any apparatus of this kind can be made effective to meet all the conditions of reversed curves, tangents succeeding curves and variations in curvature, that are found on many railroads, and it is probable that if full advantage is to be taken of the high illuminating power of gas or electric headlights on roads where much curvature exists, any motion of the headlight about its vertical axis must be within the control of the engineman.

Very strong objections are made to the use of high-power headlights, for the reason that the rays are so intense as to impair seriously for several seconds the vision of persons who may look into the beam. This effect, when experienced by enginemen of trains running in the opposite direction on parallel tracks, is considered by many to be serious. It has long been known that after a locomotive fireman has looked into the fire box for even a very few seconds in putting on coal the scotoma which persists for some seconds afterwards, makes his reading of signals at night very unreliable, until its effect has had time to pass off.

As regards the effect of the high-power beam upon the vision of the men riding on the engine on which the electric headlight is used, it has been found in some rather extensive tests that the rays were sufficiently powerful to reflect back from the surfaces of the roundels of semaphore signals an amount of light sufficient to overpower the light transmitted by the signal lamps themselves. The spectrum of the electric arc is very rich in blue and green rays and contains a relatively small proportion of the red and yellow; hence rays from the arc light reflected from the surface of the colored roundel would tend to diminish the resultant proportion of red in the light, and if reflected back from a green roundel would intensify its color. Very deceptive effects of this kind have been noticed by many observers, and while apparently such conditions may be dangerous as leading to erroneous reading of a signal light, they are largely counteracted by the fact that the high power of the light serves to reveal at a considerable distance the position of the signal arm. The usual rules governing enginemen in their interpretation of signal indications state that the indications will be displayed by day by positions of the semaphore arm, and in addition at night by lights of prescribed color, the effort being made to train the enginemen in so far as possible to depend upon position rather than upon color.—*From report of the Block Signal and Train Control Board.*

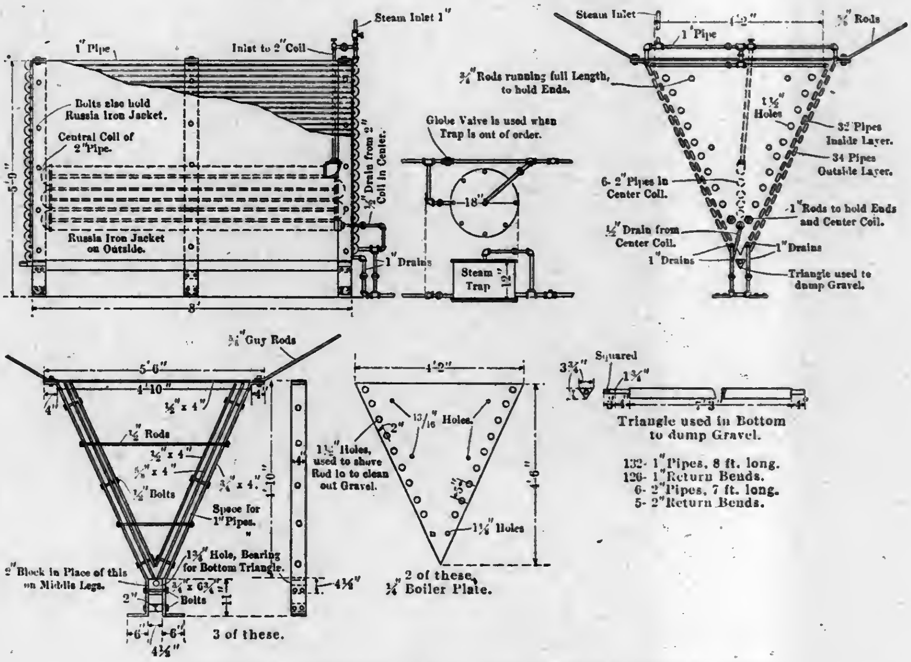
All Wire Ropes Used in Outside Operations suffer more or less from oxidation or rusting, and wire ropes running underground are frequently subjected to the corroding influence of water containing acids, which is still more destructive; and it is very necessary, therefore, that such ropes should be properly coated with some suitable material. For ropes subjected only to atmospheric conditions, a good quality of boiled linseed oil, or pine tar thinned with turpentine, will answer the purpose; but for ropes coming in contact with water, and especially with water containing acids, some of the preparations of crude petroleum, or a mixture of this with graphite, should be used.

Beeswax Makes a Perfect Lubricant when cutting threads in copper. The wax is merely rubbed into the threads.

A CHEAP AND EFFECTIVE SAND DRYER

CHICAGO AND NORTH WESTERN RAILWAY.

There are probably at least five hundred different designs of sand dryers in use in this country, and the assertion is fairly safe that the next decade will witness as many more. One peculiarity in connection with this device is that comparatively few railroads have standardized their sand stoves, leaving the design of the latter to the ingenuity of the various master mechanics. Hence the schemes for sand drying range from a simple bed of steam pipes, on which the sand is laid, to most elaborate contrivances, but in the long run, so far as securing the purpose for which intended, there is little to choose from between any of them.



DETAILS OF SAND DRYER—CHICAGO AND NORTHWESTERN RAILWAY.

The sand dryer illustrated herewith is the latest addition to a formidable collection of similar devices. It embodies the novelty of being constructed entirely of pipe, and will no doubt be of interest where the installation of sand drying facilities is in contemplation. One and two inch pipe is used, and the detail drawing clearly indicates the manner in which it is run. This pipe constitutes the heating surface, and the area of the latter combined with the capacity of the dryer is sufficient to take care of the needs of a large terminal, for instance, one handling one hundred engines in twenty-four hours. At the bottom of the dryer is a triangular piece of iron which is held on bearings at either end. One of these ends is squared for the reception of a wrench which allows it to be turned so that the gravel can be dropped out. To further facilitate this operation the 1/4 in. boiler plate which encloses the ends of the dryer is perforated with a number of 1 1/2 in. holes through which a rod can be inserted to start the gravel down. The sides of the dryer are enclosed by Russia iron boiler jacket bolted to suitable wrought iron strip.

The device appears to be thoroughly practical, and is certainly inexpensive. It has been in use at the Clinton roundhouse of the Chicago and Northwestern Railway for a number of years, and is said to have given perfect satisfaction.

In the Last Three Years 840 Locomotives have been withdrawn from service on the Russian State railways, and it has been decided to fix the maximum life of a locomotive at 25 years for the future.

ASBESTOS SHINGLES AND SHEATHING FOR FIREPROOFING RAILROAD BUILDINGS

The application of asbestos to secure fireproofing for the various classes of railway buildings is being accorded considerable attention at present as is evinced by several recent structures wherein its use is embodied. An installation of this product which should prove of particular value may be found at the New Durham shop of the New York Central Railroad, where seventeen single and five double roundhouse smoke jacks have been included in connection with the new plant under construction. These asbestos lumber smoke jacks as distributed by the Franklin Mfg. Co. are absolutely fireproof; are not subject to deterioration and corrosion, and being very light in construction a great saving can be effected in roofing timbers.

In the matter of fireproof construction there is probably no material on the market which is being more generally considered than the asbestos corrugated sheathing and asbestos shingles. These materials are an asbestos concrete production made under hydraulic pressure, and the action of the atmosphere on the cement vitrifies the materials and preserves them for an indefinite period. They are impervious to the action of sulphurous gases and acids and the fumes prevalent around railroad shops and buildings, and once applied they require no cost for maintenance. The asbestos corrugated sheathing may possibly come a trifle higher than the best grades of corrugated iron, in first cost, but when the life of the material is considered, and the fact that the asbestos corrugated requires no paint or other cost for maintenance, it is much cheaper in the long run.

No Platform Gates at the Boston South Station.—In striking contrast to the barriers interposed at the platform entrances in the majority of great terminals is the utter disuse of gates in the Boston South Terminal station of the New York, New Haven and Hartford Railroad. Despite the lack of these adjuncts, however, it should be remembered that the South Station operates 876 daily passenger trains, on summer schedules, and handles about 20,000,000 people per year without the slightest inconvenience. A remarkable fact in connection with this departure from time-honored observance is that no one abuses the privilege, and the platforms are always clear for incoming and departing passengers.

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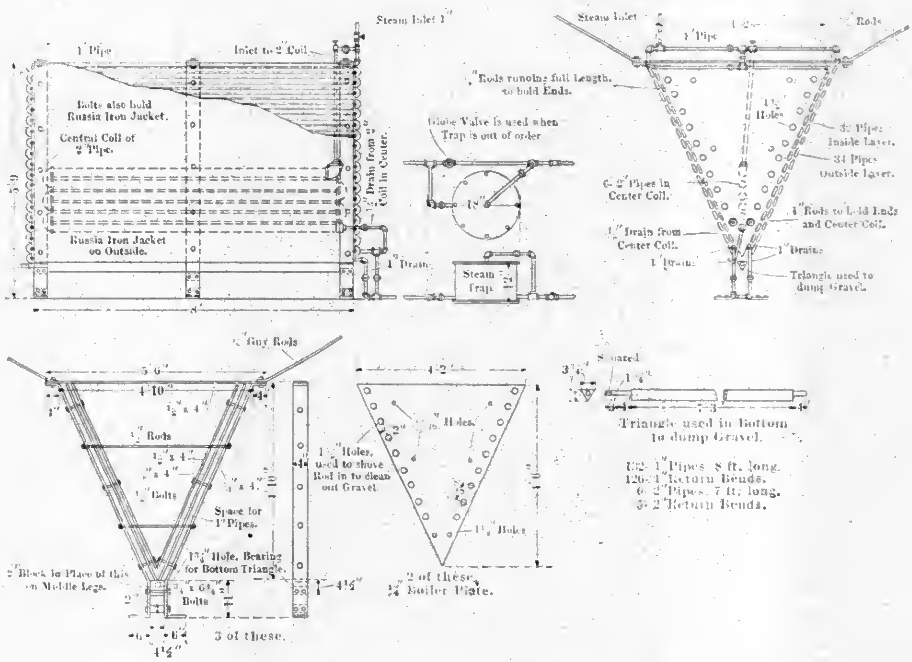

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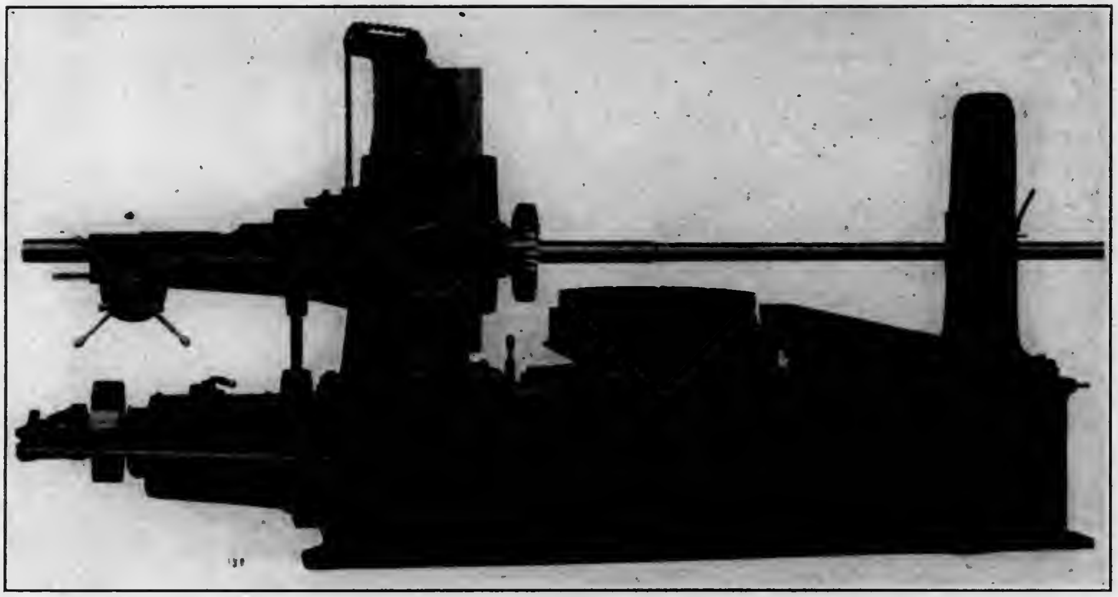
NEW DESIGN HORIZONTAL BORING MACHINE WITH SPECIAL FEATURES

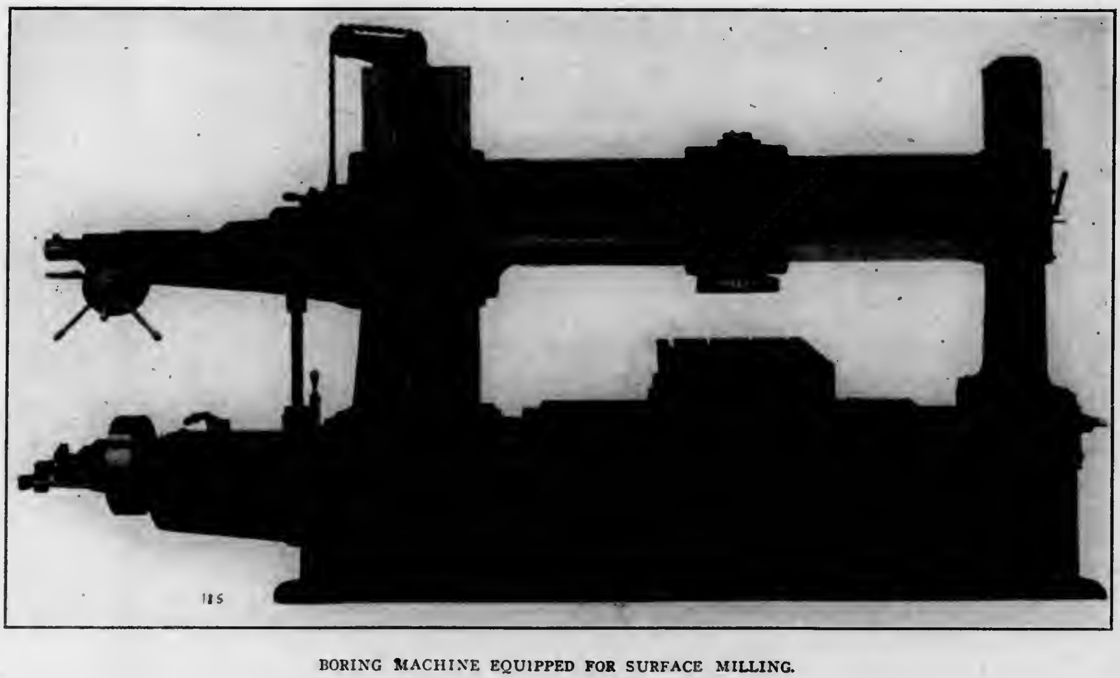
The latest output in horizontal boring mills by the Lucas Machine Tool Co., of Cleveland, O., is the successful result of many patient years of work and experiments by the designers to secure the highest possible development in this particular tool. Previous to the year 1900 the horizontal boring mill was considered very largely in the light of a necessary evil. It is no doubt well remembered that its imperfect design made it practically impossible to bore holes parallel, or an exact distance apart, and as it was incapable of doing any class of work except boring and drilling, it was often idle and was unpopular accordingly.

Some years ago, however, the Lucas Machine Tool Co., having recognized the inherent possibilities of such a machine, determined to take advantage of the situation, and work toward the production of a machine of broader usefulness. It is to this that they have given the name "Precision," in which the old type of knee construction is reversed, milling feeds and power movements included without complication, and resulting in a permissible range of work so wide that it would be undreamed of in the old days. The machine in its present form is the result of ten years of development and improvement. A proper distribution of metal insures strength, and the parts most subject to strain are amply proportioned to stand severe service. Simplicity of construction has been kept in mind, and all complication studiously avoided. The unusual accuracy of the tool insures that all the different cuts taken are true with each other, and serves largely to account for its extensive use in shops where the best quality of production is a necessity.

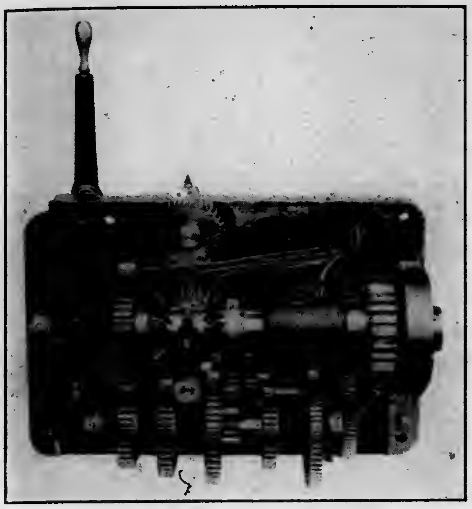


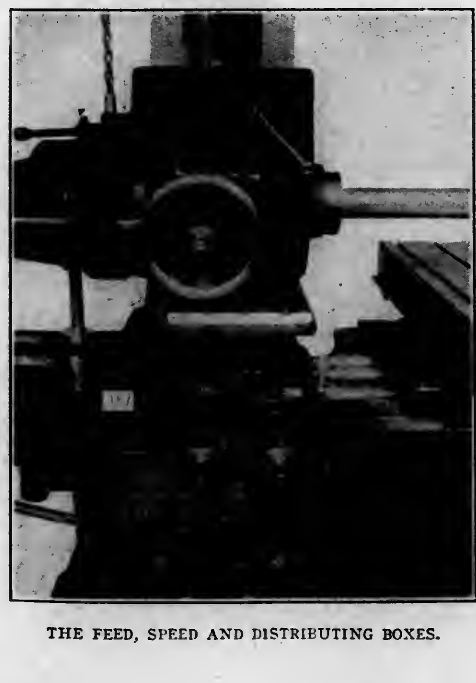
THE NO. 32 LUCAS PRECISION BORING MACHINE.

The principal feature of the No. 32 machine, herein illustrated, which differs from former machines, is that it has constant speed quick power movements to all parts having feeds and this is so arranged that no matter what feed is used, the quick return for that feed is obtained by simply moving the feed



BORING MACHINE EQUIPPED FOR SURFACE MILLING.





THE FEED, SPEED AND DISTRIBUTING BOXES.

engaging lever in the reverse direction. This lever is shown in the photograph just above the feed levers, and to the right of the gear box on top of the bed. When it is in the left-hand position it gives a quick vertical movement to the head, a quick cross movement to the platen, or a quick longitudinal movement to the saddle or to the spindle, depending upon the position of the interlocking levers on the cover of the gear box on top of the bed. When the feed engaging lever is in the right-hand position, the corresponding feeds are obtained.

The feed is operated by two levers controlling sliding gears and giving nine changes for either position of the spindle back gears, which gives a total of eighteen changes ranging from .004 in. to .600 in. per revolution of the spindle. These feeds may be applied to the spindle, spindle head and tail block, saddle and platen; they are so arranged that not more than one feed can be engaged at the same time, and it is also impossible to use the power movement when any feed is engaged, or to engage any feed when the power movement is in use. All feed screws are true to pitch, and are provided with dials graduated to read to thousandths of an inch, which allows the work to be done accurately and interchangeable parts produced without the use of jigs. The machine may be driven by belt or by a direct connected motor. If by belt, the speed should be such as to drive the 16 in. pulley on the machine 300 r. p. m.; if electrically driven, a 7½ h. p. constant speed motor running at 1,000 to 1,200 r. p. m should be used. These speeds give the spindle a range of from 7½ to 150 r. p. m. The machine will take work 6 ft. long between the face plate and the outer support, and has a 36 in. cross feed provided with an automatic trip.

The foundation principle of this machine, in common with all those of the "Lucas Type," is raising and lowering the spindle head, which is a constant weight instead of raising and lowering the table with its load, which is widely variable. This construction allows the use of a deep bed of great stiffness, which gives a solid foundation to the other members of the machine, and keeps them in accurate relation to each other in all positions. The bed is of complete box section, well ribbed, and with a continuous bottom, the strongest form in which the metal can be distributed. As a result the machine is thoroughly self-contained and can be satisfactorily operated without building a foundation under it. This permits it to be moved from one part of the shop to another as changes in conditions demand The top of the bed is protected by guards, which are so designed that they make convenient tool pans.

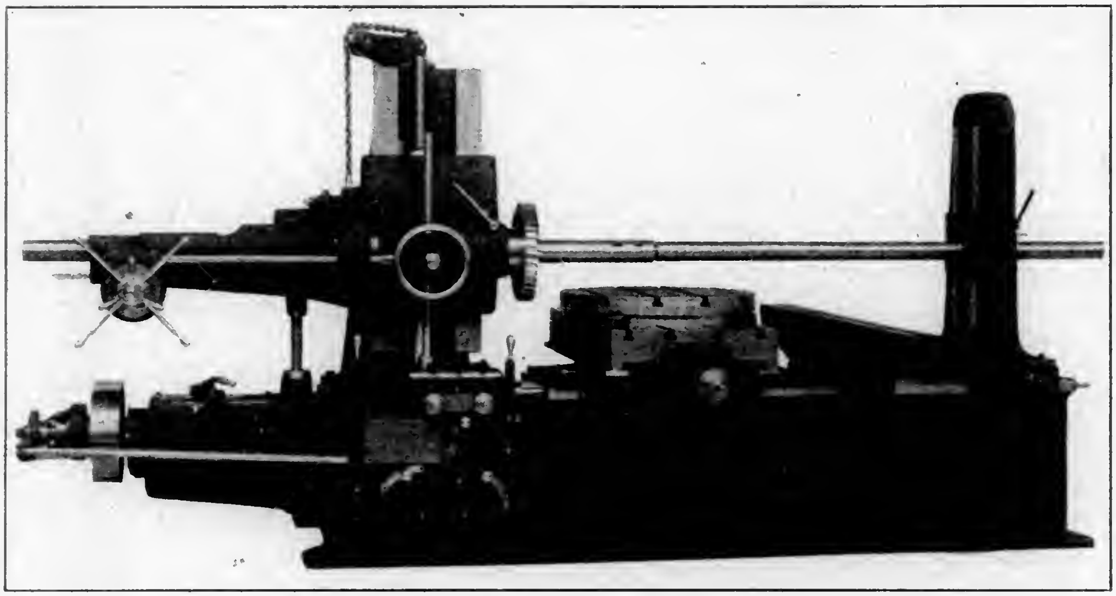
The backrest which carries the tail block is symmetrical in design, of complete box section and has a base with liberal bearings on the bed. To accommodate long work, the backrest can be taken from its base simply by removing four screws, without disturbing any other mechanism, and without impairing the general rigidity of the machine. The base can be adjusted along the bed by means of a wrench operating a pinion meshing with the saddle adjusting screw, which in this instance serves as a rack. The base is gibbed to the bed and has a clamping screw to secure it in any desired position. The tail block has long "V" bearings, which makes it impossible for the backrest to spread, with the result that when the tail block and backrest are bound together, they become practically one piece.

The spindle head and tail block are raised and lowered together, being connected by a shaft and planed bevel gears. The spindle is of hammered crucible steel, accurately ground its entire length, and cannot be lowered far enough to come in contact with the top of the platen. It does not revolve in boxes, but slides through a sleeve. This latter is of a solid high carbon steel forging; it has a conical journal at the front, revolving in a solid bronze box; and a cylindrical journal at the rear revolving in an adjustable bronze box. The spindle drive is transmitted in the most direct manner possible from the source of power to a gear of large diameter on the spindle sleeve. The back gears are on the head, which is the proper place for them, and are engaged and disengaged by a convenient lever.

Another photograph shows this machine arranged as a Vertical Milling Machine by means of a cross rail bolted to the

NEW DESIGN HORIZONTAL BORING MACHINE WITH SPECIAL FEATURES

The latest output in horizontal boring mills by the Lucas Machine Tool Co., of Cleveland, O., is the successful result of many patient years of work and experiments by the designers to secure that they have given the name "Precision," in which the ol type of knee construction is reversed, milling feeds and pow movements included without complication, and resulting in permissible range of work so wide that it would be undreame of in the old days. The machine in its present form is t result of ten years of development and improvement. A prop distribution of metal insures strength, and the parts most su

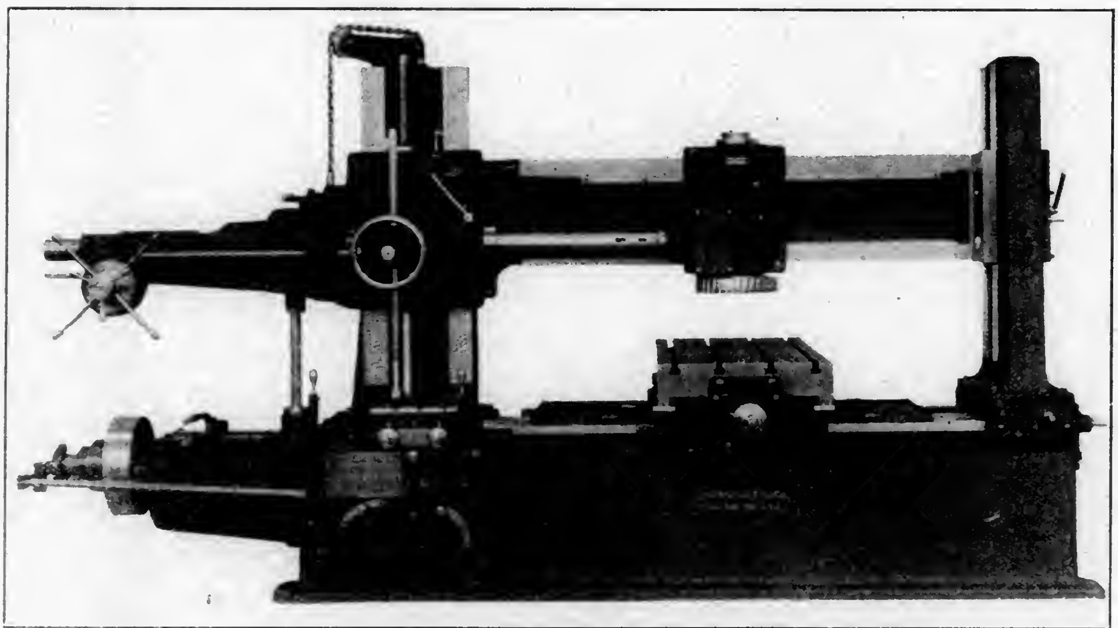


THE NO. 32 LUCAS PRECISION BORING MACHINE.

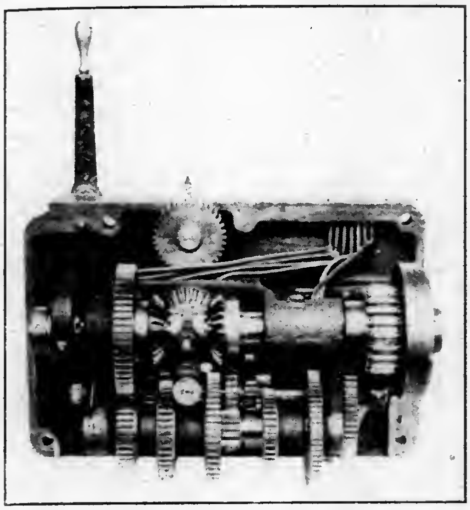
the highest possible development in this particular tool. Previous to the year 1900 the horizontal boring mill was considered very largely in the light of a necessary evil. It is no doubt well remembered that its imperfect design made it practically impossible to bore holes parallel, or an exact distance apart, and as it was incapable of doing any class of work except boring and drilling, it was often idle and was unpopular accordingly.

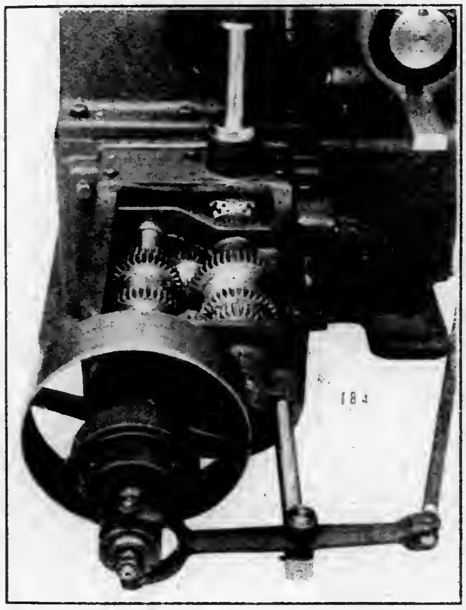
Some years ago, however, the Lucas Machine Tool Co., having recognized the inherent possibilities of such a machine, determined to take advantage of the situation, and work toward the production of a machine of broader usefulness. It is to this ject to strain are amply proportioned to stand severe service. Simplicity of construction has been kept in mind, and all complication studiously avoided. The unusual accuracy of the tool insures that all the different cuts taken are true with each other, and serves largely to account for its extensive use in shops where the best quality of production is a necessity.

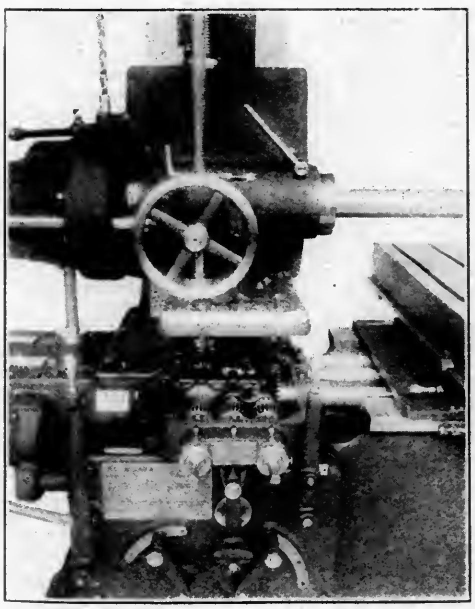
The principal feature of the No. 32 machine, herein illustrated, which differs from former machines, is that it has constant speed quick power movements to all parts having feeds and this is so arranged that no matter what feed is used, the quick return for that feed is obtained by simply moving the feed



BORING MACHINE EQUIPPED FOR SURFACE MILLING.







THE FEED, SPEED AND DISTRIBUTING BOXES.

engaging lever in the reverse direction. This lever is shown in the photograph just above the feed levers, and to the right of the gear box on top of the bed. When it is in the left-hand position it gives a quick vertical movement to the head, a quick cross movement to the platen, or a quick longitudinal movement to the saddle or to the spindle, depending upon the position of the interlocking levers on the cover of the gear box on top of the bed. When the feed engaging lever is in the right-hand position, the corresponding feeds are obtained.

The feed is operated by two levers controlling sliding gears and giving nine changes for either position of the spindle back gears, which gives a total of eighteen changes ranging from .004 in. to .600 in. per revolution of the spindle. These feeds may be applied to the spindle, spindle head and tail block, saddle and platen; they are so arranged that not more than one feed can be engaged at the same time, and it is also impossible to use the power movement when any feed is engaged, or to engage any feed when the power movement is in use. All feed screws are true to pitch, and are provided with dials graduated to read to thousandths of an inch, which allows the work to be done accurately and interchangeable parts produced without the use of jigs. The machine may be driven by belt or by a direct connected motor. If by belt, the speed should be such as to drive the 16 in. pulley on the machine 300 r. p. m.; if electrically driven, a 7½ h. p. constant speed motor running at 1,000 to 1,200 r. p. m should be used. These speeds give the spindle a range of from 7½ to 150 r. p. m. The machine will take work to it. long between the face plate and the outer support, and has a 36 in. cross feed provided with an automatic trip.

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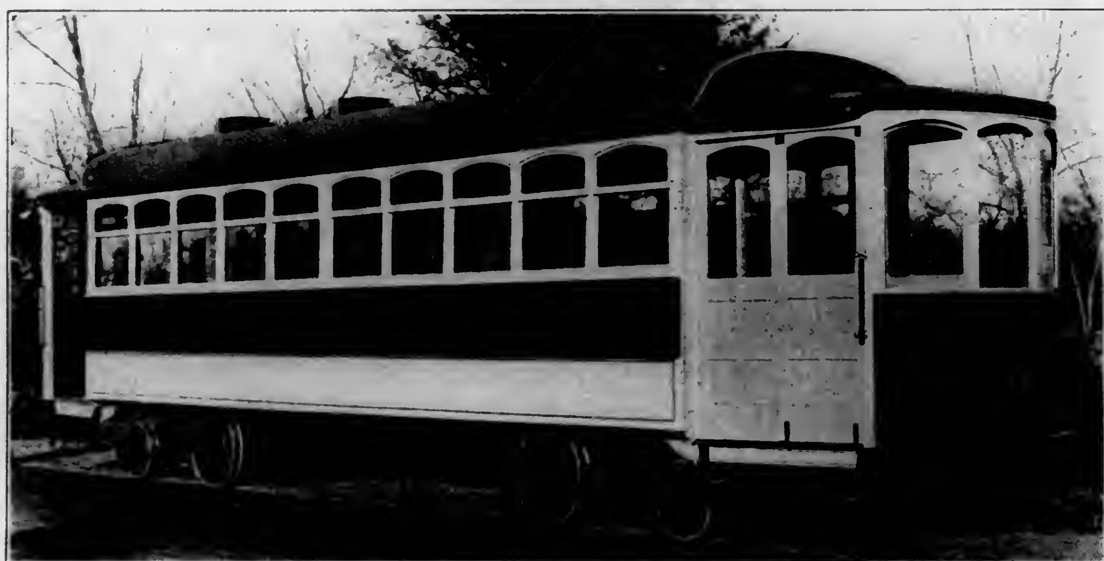
head carrying the horizontal spindle and the outer support. On this cross rail slides the head carrying the vertical spindle which is fed along the rail either by hand through the rack and pinion movement or by the power traverse to the boring bar and all vertical adjustments can be made either by hand or by power as may be desired. The vertical spindle is constructed along the same lines as the horizontal spindle, which is of forged steel, and has a large taper front bearing as in modern milling machine construction. This runs in a solid bronze bushing in the solid head of the machine with a collar between the shoulder, on the end of the spindle, and the end of the bronze bushing. This makes a very solid construction, and a very slight reduction in the thickness of this collar allows for any adjustment that may be necessary after long use. The rear bearing is straight, but the split bushing is taper on the outside and can be adjusted by the locking nuts shown to compensate for all wear.

Milling cutters of large diameter, like the 12 in. cutter shown are bolted directly to the spindle flange. It will readily be seen that the combined movement of the head and platen gives this form of machine an extremely wide range for surfacing work.

A Practical Storage Battery Car

RECENT EXPERIMENTS ON THE ERIE RAILROAD WITH THE NEW BEACH CAR EQUIPPED WITH EDISON STORAGE BATTERIES INDICATE THAT A SOLUTION IS IN SIGHT TO THE PROBLEM OF PROVIDING CHEAP AND EFFICIENT TRANSPORTATION ON BRANCH LINES AND UNDER CONDITIONS WHERE THE STEAM LOCOMOTIVE IS UNECONOMICAL.

For many years the fact has been plainly apparent to motive power management in general that the steam locomotive, with the attendant expense of its own and the train crew, is no longer profitable on small branch lines or under any condition where the traffic is light and variable. Such instances are common both in this country and abroad; in fact, it may be said that scarcely any trunk line of importance can fail to afford an example. The constantly expanding trolley systems, frequently paralleling the steam roads, and operated at a comparative wage cost vastly less, have added to the complication and the seriousness of the question, until in many instances the railroads would have been practically justified in abandoning certain of these branches on which money is steadily being lost.



THE BEACH CAR EQUIPPED WITH EDISON STORAGE BATTERIES.

In the large majority of cases, however, it is found that it would be impracticable to so discontinue the service, as the branches make close connection with main line express and suburban trains, and more frequently the railroad has vital interests on the branch in question which necessitate, if they do not demand, its operation.

Various solutions to the problem have been sought in electrification, which, however, is not generally resorted to, owing to the prohibitive cost of the third rail or the trolley system, when compared with the revenue expected; by gasolene motor cars, and even light steam cars, but despite the variety of ingenuity displayed in coping with the situation, it has not by any means deterred the efforts of those who believed that the self-propelled vehicle was the most likely solution, and stored electricity the best medium.

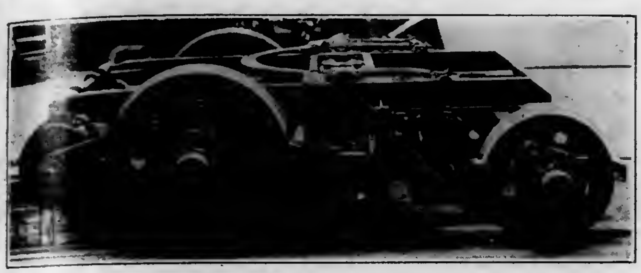
Unsatisfactory developments in storage batteries, however, which remained prominent for many years, in connection with the application of electricity to such comparatively heavy service as demanded by the railroad, precluded any successful experiments in this line until a somewhat recent period, when the Beach car, equipped with the Edison storage battery, was put to work on a street railway of New York City. The pronounced success of this car, after several months regular service, attracted widespread attention to the system, the outcome of which was the purchase of the car herein illustrated by the Erie Railroad.

Since November 14, 1910, it has been running regularly on a branch of that railroad from Forest Hill, N. J., to West Orange, N. J., a distance of somewhat over four miles, and has been easily maintaining the schedules assigned to the former steam service. This car was in reality primarily intended for street railway service, which is evinced by the very long platforms for easy entrance and exit under the pay-as-you-enter system, and it has also maximum traction trucks, better adapted to city conditions than to country running as on the branch where in service.

Nevertheless, although the car was not constructed with the requirements of the Erie under consideration, its performance for the latter has been such that much interest has been awakened, and it is believed that it will be the means of effectually

solving the vexatious problem which has been commented upon It has invariably made its runs on time, even during blizzard weather, and is felt to be fully dependable for the service by those interested.

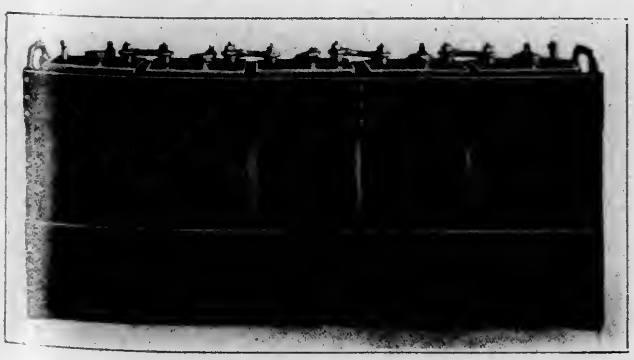
Some interesting figures are available in regard to the economical results which have been attained; for instance, on a recent test run of 48 miles from West Orange to Forest Hill, thence



MAXIMUM TRACTION TRUCK.

to Greenwood Junction, thence to Newark, and thence to Paterson and return to West Orange, the batteries were only charged one hour for the entire run. The power consumption on the 48 miles averaged 625 watt hours per car mile, or 43 watt hours per ton mile, which is about the average power consumption of the car on its regular runs between West Orange and Forest Hill. Electric current costing 2 cents per kilowatt hour would, therefore, make the power cost in this case 1¼ cents per car mile. In this special run, to test out the car over greater distances, the maximum speed attained was 32 miles per hour, and the average between stops 25 miles per hour. From the viewpoint of acceleration the car shows remarkable efficiency, as nearly as can be determined reaching its maximum speed on level and straight track in 1,000 feet.

The car herein illustrated is 28 ft. long, inside of corner posts, and 7 ft. 6 in. wide over deep rail. The platforms are 6 ft. 1½ in. long, and the overall length of the car is 40 ft. 3 in. The car is of steel channels, I beams and steel sheathing throughout, with selected white ash trim. Arched roof is used, instead of the usual monitor, or double-decked roof. The attractiveness, strength and lightness of this roof is obvious. It is formed of two eccentric arches, and is a much stronger roof than is possible in monitor form. It allows increased head room, affords by automatic ventilators in the top a uniform and adequate ventilation, and permits of the double sash and high window, not possible with the old form of roof. The roof is supported by vertical rust-proofed (in black) steel tubes, which serve also as grab rails instead of the usual strap; these vertical tubes are, in turn, supported by the longitudinal lattice steel girder, which also supports the seat and serves as a battery case and "back bone" on each side for the entire car structure. The horizontal steel



THE EDISON A8 STORAGE BATTERY.

tubes, which are enameled white, serve as conduits for the lighting cables, and supports for the lamp, bell and fare register cord fixtures.

Notwithstanding the steel construction, the entire weight, complete with 180 A8 cells of battery, is about 30,000 lbs., or about 725 lbs. of dead weight per seated passenger. Careful design, selection and distribution of materials, elimination of all useless fixtures and weight in materials, such as the arched instead of monitor deck roof, the open instead of the full bulkheads, etc., has made possible this great reduction in dead weight and still permitted a safe factor of strength.

The interior is provided with 10 c.p. lamps There is such a lamp on each platform, and lamp of larger capacity in each headlight carried in multiple arc, so that any number may be used, and their current is taken from a special set of battery cells, which are charged, however, in series with the power battery.

The truck, which is herein illustrated, is of interesting construction. It is what is known as the Maximum Traction type and in it an entirely new method of design is followed. The axles are of chrome steel I beam sections, each forged with 3¾ in. ends inserted into the bearings, which are of the "Rollway" type, and are contained in the hub of the wheel. These bearings eliminate friction to a large extent and are inexpensive to maintain. The axles do not revolve, each wheel rotating independently of the other, thereby eliminating all wheel slipping; for example, on a tangent track because of the varying diameter of all car wheels, and particularly at curves because of the inde-

INTERIOR OF STORAGE BATTERY CAR.

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As usual in maximum traction trucks, the Beach Maximum Traction truck carries the load principally on the driving or large wheels, and each driving wheel is independently driven by a 10 h.p. motor, the location of which is shown plainly in the illustration. Four such motors, provided with ball bearing journals are required for each car. They have ample capacity for the loads and speed required, have a safe factor for overloads, and are especially smooth at acceleration Oxy-acetylene welding has been resorted to throughout the truck, which contains no bolts or rivets, and in fact the somewhat novel application of this process is in evidence in several quarters in connection with the steel underframe. The provisions made for motor suspension, especially in connection with the chain drive, which can be readily maintained at the desired tautness; the details of the truck, and the spring action, are especially well worked out. Both hand and air brakes are provided in the car under consideration.

The Edison battery, as applied to Beach cars, has a mileage capacity, per single normal charge, at the normal low charging rate, and for seven hours, at from 60 to 100 miles in the single truck cars, and from 80 to 125 miles in the double truck cars, this particular car has a range per battery charge of 115 miles, using 180 A8 cells. By giving the battery short intermediate charges, or "boosts," of from 5 to 30 minutes duration each, occasionally

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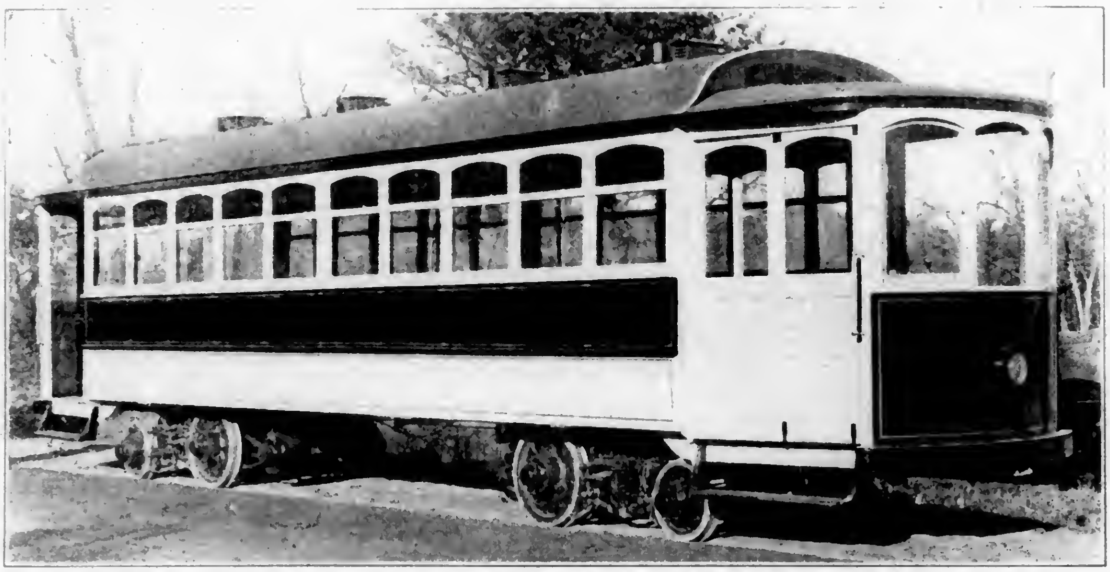

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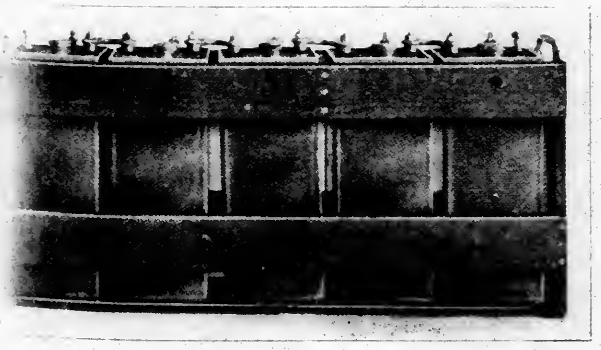

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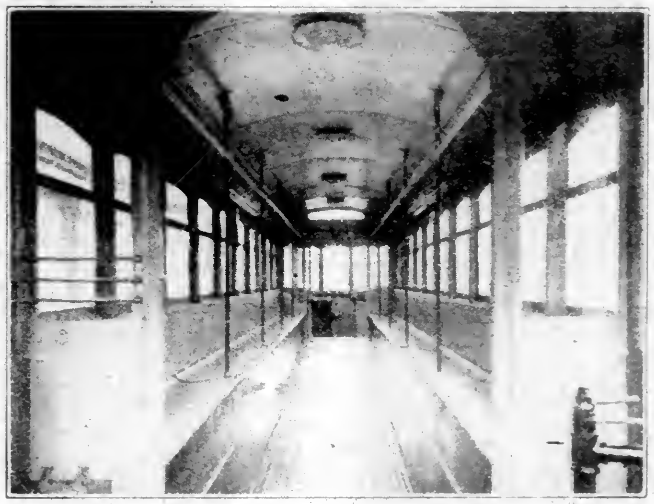

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during the day's work, a much greater mileage may be obtained without damage to the battery and at a lower average power consumption. The average watt hour efficiency of the Edison battery is 61 per cent. based on the normal battery charge mentioned above. The average watt hour efficiency on the short intermediate charges or "boosts" at the high charging rate is about 98 per cent., therefore the efficiency, when operating the battery on the normal charge, together with the "boosts" occasionally, brings the average efficiency of the battery up to 80 or 85 per cent., according to the skill used in charging the battery.

The cost of keeping the Edison battery full of pure water, and renewing the 21 per cent. solution of caustic potash and water once every eight months, averages about 3 mills per car mile, and this is all the battery maintenance required to keep the battery up to its highest efficiency. The Federal Storage Battery Car Company, manufacturers of this car, have data to indicate that the battery will endure in ordinary car operation for a long period of years. They have been in use, without important deterioration, for five years, and there is no reason to doubt that they would not last as long as other ordinary railway equipment.

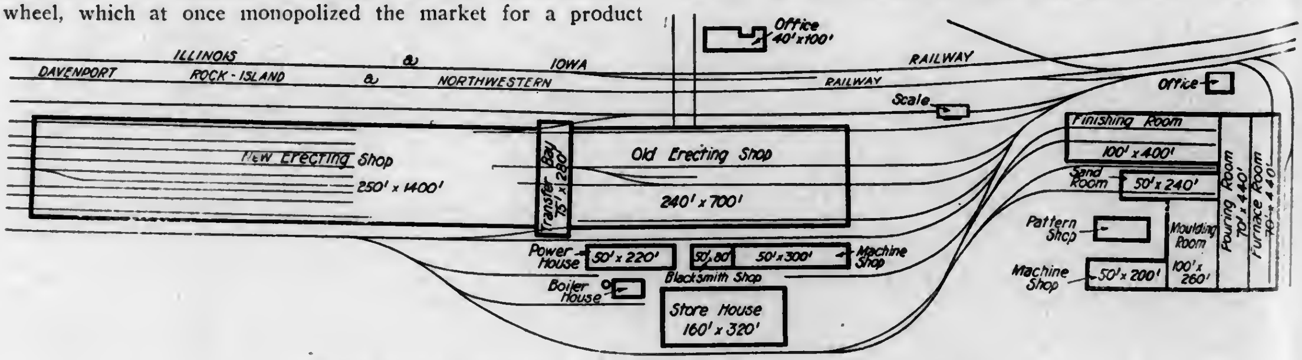
Estimating the cost of operating these cars, including crew, cost of power, and basing the cost of battery on the guaranteed life only, and including depreciation of the electric motors, car structure, truck, etc, with interest and all fixed charges, it is thought that 15 cents per mile will cover the entire operating expense.

Bettendorf Steel Car Plant

The late W. P. Bettendorf was a man whose inventive and mechanical genius has never been questioned, and the magnificent plant that stretches along the Mississippi river for nearly a mile stands as a monument to his ability for the building of the organization, which is to-day conducting one of the most successful manufacturing enterprises that furnishes equipment to the railroads of this country. Probably Mr. Bettendorf's personality and his genuineness have been largely responsible for the loyalty and the enthusiasm of the men who were associated with him in the building of the Bettendorf industry.

GENERAL VIEW OF BETTENDORF STEEL CAR PLANT, BETTENDORF, IOWA.

In 1886 Mr. Bettendorf went to Davenport, Ia., for the purpose of engaging in the manufacture of metal wheels. He had patented a new and novel metal wheel and a method of manufacturing it. Within a short time he had established the success of the new enterprise; and the decided merit of the new wheel, which at once monopolized the market for a product of that kind, has made it to-day the leading wheel for agricultural implements.



PLAN OF CAR SHOP AND STEEL FOUNDRY; BETTENDORF AXLE COMPANY.

Always of an inventive turn of mind, Mr. Bettendorf next invented and became the patentee of a steel gear for farm wagons and other vehicles, and closing out his interest in the metal wheel plant, he organized a company, with himself at the head, for the manufacture of the wagon. This business quickly assumed large proportions, and in connection with it was begun the manufacture of some railway equipment specialties. Associated with him in his business enterprises was his brother, J. W. Bettendorf, on whom a great deal of the responsibility for the successful conducting of the business fell, and to whom large credit is due for the present large proportions to which the company has developed.

The invention by W. P. Bettendorf, and the manufacture of the I-beam car bolsters by the Bettendorf company, marked the beginnings of a railway supply manufacturing concern which had a most phenomenally successful growth within a period of a few years. Following the invention of the I-beam bolsters came the one-piece cast steel truck frames and other steel parts for the railway freight car. The immediate success which marked the introduction of these various railway freight car specialties determined the inventor to devote his attention almost exclusively to the manufacture of steel railway car parts, and eventually cars in their entirety. The necessity soon became apparent for the establishing of a large separate plant for this purpose, and a site comprising about 40 acres was secured in 1902, and the first buildings now comprised in the present plant were erected. The location selected was just east of the

city limits of Davenport, where a new town was laid out and given the name of Bettendorf.

The indefatigable energy of W. P. Bettendorf, together with his mechanical knowledge and experience and his remarkable talent for organization, within a few years evolved a business of large proportions. Last year, when the business was only upon the threshold of its success, its founder, while most actively devoting himself to the enlargement of the plant and the business in every direction, was suddenly stricken and died on June 3, 1910.

J. W. Bettendorf, who had been associated with his brother since the beginning, shouldered the added responsibility and set to work to carry forward and complete the plans for the fabricating and erecting shop 1,400 by 250 ft., which is a steel frame and brick building, 60 ft. high, making one large main shop 2,100 by 250 ft. There has also been erected a large steel foundry, with wings arranged as shown in the illustration. To the south of the main shop is the power house, 220 by 50 ft., machine and blacksmith shop, 380 by 50 ft., and the storehouse, 320 by 160 ft.

In the main shop, where the underframes and cars are fabricated and erected, there are fifteen electric traveling cranes of from 3 to 10 tons capacity, having approximately 60 to 70 ft. spans. In the older section of this shop, which is divided into five bays, are manufactured bolsters in two bays and small car parts and truck springs in two bays, the center bay being

BETTENDORF STEEL FOUNDRY.

further enlargement of the Bettendorf industry. The Bettendorf company, with J. W. Bettendorf at its head, and ably assisted by J. H. Bendixen, its vice-president, with a large and experienced organization, aims to develop at Bettendorf, Ia., the most comprehensive plant in the country for the manufacture of steel railway car underframes and parts, and eventually of steel cars of every description in their entirety.

With the several tracts recently purchased the grounds now in use cover an area of about 100 acres, and the buildings have a total aggregate floor space of upwards of 800,000 sq. ft., or about 18 acres, that is under roof. From the east side of the foundry to the tracks at the west end of the main shop is nearly a mile, and the total acreage of the land now owned by the company on which the present plant is located, and that which is held for future extension, amounts to 240 acres.

The original shop was a brick structure 700 by 240 ft. and in the recent improvements there has been added to it a main used principally for storage and assembling of parts. In the transfer bay, between the old and new sections, are located cranes, magnets, etc., for distributing material from the old shop to the four bays of the new addition. In the new section the two north bays are used for the erection of underframes of steel cars. In the next bay floors and sides are applied and in the south bay small parts and specialties are stored. There are 39 hydraulic presses in this shop, ranging in capacity from 50 to 250 tons, all of which have been specially designed and built by the Bettendorf Company. Running through the shop longitudinally are eight full gauge tracks connecting with the yard track system. Two locomotives and two locomotive cranes are used for transporting material around the yard. The heating of the shop is by Evan-Almiral hot water system, having 75,000 sq. ft. of radiation.

In this shop are manufactured the Bettendorf underframes for freight cars, of which there are now 45,000 in use, as well

ONE-HALF ERECTING BAY; BETTENDORF STEEL CAR SHOP.

during the day's work, a much greater mileage may be obtained without damage to the battery and at a lower average power consumption. The average watt hour efficiency of the Edison battery is 61 per cent. based on the normal battery charge mentioned above. The average watt hour efficiency on the short intermediate charges or "boosts" at the high charging rate is about 98 per cent., therefore the efficiency, when operating the battery on the normal charge, together with the "boosts" occasionally, brings the average efficiency of the battery up to 80 or 85 per cent., according to the skill used in charging the battery.

The cost of keeping the Edison battery full of pure water, and renewing the 21 per cent. solution of caustic potash and water once every eight months, averages about 3 mills per car mile, and this is all the battery maintenance required to ke the battery up to its highest efficiency. The Federal Storage B tery Car Company, manufacturers of this car, have data to in rate that the battery will endure in ordinary car operation for a ong period of years. They have been in use, without imp ant deterioration, for five years, and there is no reason to doub hat they would not last as long as other ordinary railway equip ent.

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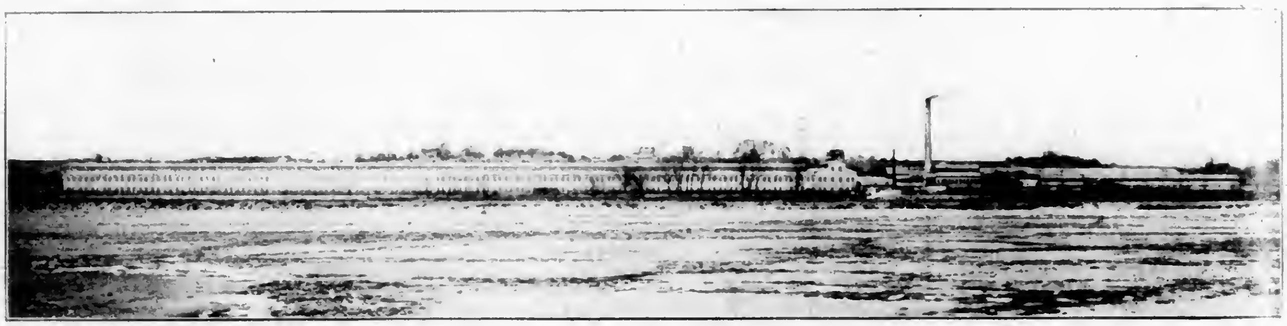

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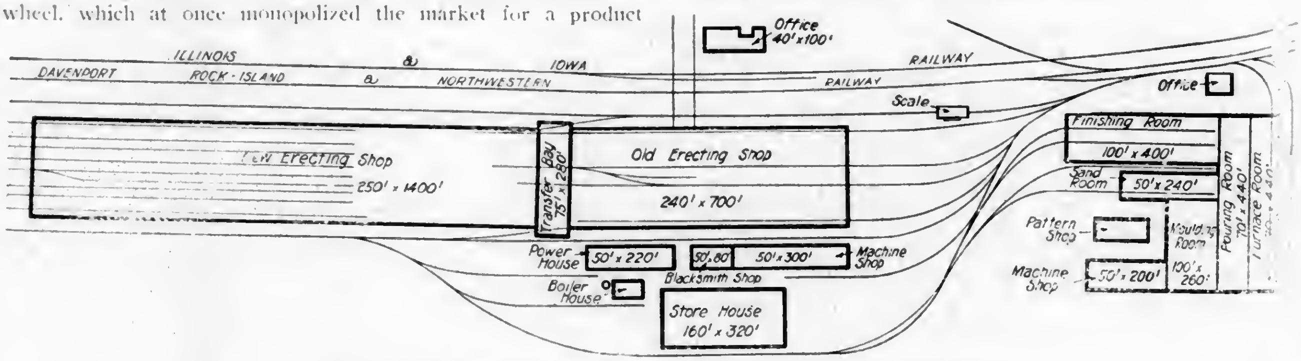

PLAN OF CAR SHOP AND STEEL FOUNDRY; BETTENDORF AXLE COMPANY

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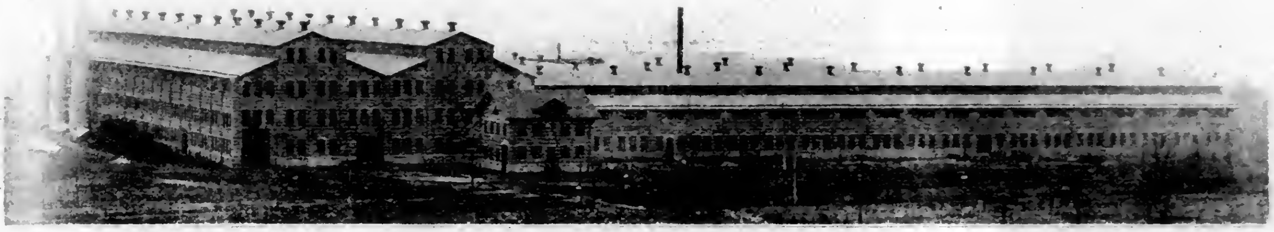

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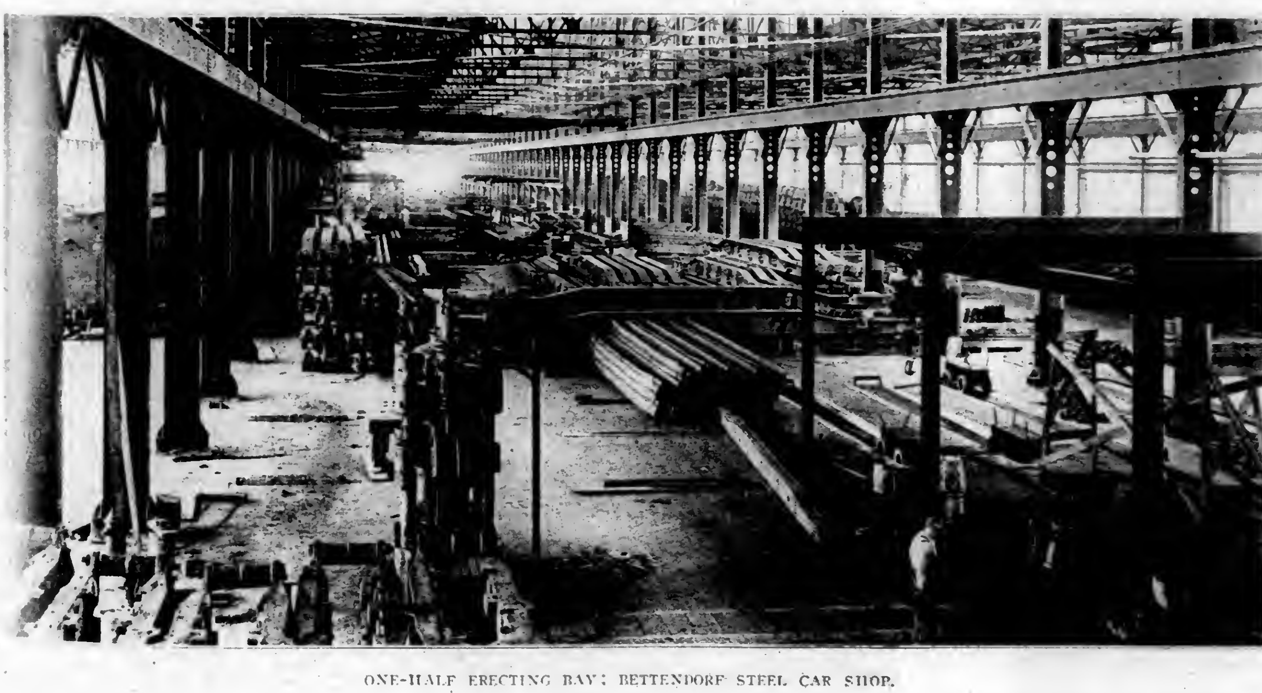

ONE-HALF ERECTING BAY; BETTENDORF STEEL CAR SHOP.

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All of this equipment is manufactured from commercial sections, shaped cold in specially designed hydraulic presses of great power. Powerful lifting magnets are very generally used

2,500-TON HYDRAULIC PRESS FOR CENTER SILLS.

throughout the shop for handling the different parts and compressed air handling and feeding machines, specially designed by the company, form a most interesting part of the equipment.

The main machine shop is devoted entirely to the building and repairing of hydraulic presses, machines, etc., used throughout the plant. It is thoroughly equipped with up-to-date and strictly modern motor-driven tools in large sizes. A 5-ton crane serves the shop. The blacksmith shop is similarly used for building and repairing tools used in the shop.

The steel foundry was added to the plant last year and is one of the most modern and thoroughly well equipped plants of its kind in the country. All of the equipment for rapid output, accuracy of composition in the metal, and positive control of temperatures, etc., have been installed. Not the least interesting feature in this foundry is the perfection to which the annealing process has been brought and the extreme care used in annealing the many complicated castings. While this foundry will only supply a small part of the castings used by the company it is planned to gradually enlarge it until probably one of the largest steel casting plants in the country will be located there. At present it is used principally on orders that require immediate delivery and on castings that require special attention. Since it has been opened the company has found itself in a position to put on the market a satisfactory one-piece cast steel bolster.

The furnace bay, 70 ft. x 440 ft., is equipped with two 5-ton, 70-ft. span, electric traveling cranes for handling molds and castings; one 3-ton electric traveling wall crane; one 35-ton, 70-ft. span ladle crane with a 35-ton main hoist and a 5-ton auxiliary hoist and two 3-ton jib cranes for handling the furnace spouts. Through this department is a continuous sand conveyor for handling sand and conveying it to the sand mixers in the sand room. The two molding rooms, each 260 ft. x 50 ft., are equipped with two 5-ton, 48-ft. span, electric traveling cranes and miscellaneous jib cranes, pneumatic ramming tools, Bettendorf molding machines and core machines, and a continuous sand conveyor delivering sand at the various machines from the sand mixer. The sand room, 240 ft. x 50 ft., is equipped with concrete bins for sand storage, one 5-ton, 48-ft. span, electric crane with ½ yard grab bucket, two 25-ton continuous heavy sand mixers and two 15-ton facing sand machines. The annealing and chipping rooms, arranged in two bays each 400 ft. x 50 ft., are equipped with two continuous annealing ovens of the Bettendorf design which greatly expedite the process and render castings of a uniform quality. A Bettendorf hydraulic press, of 775 tons capacity, specially designed for this service, is used to straighten and test the truck frames to insure perfect alignment. Five ton, 48-ft. span, electric traveling cranes are used to carry castings to the various parts of these departments and for loading castings on cars.

A metal pattern and machine shop, 200 ft. x 50 ft., occupies another bay of this structure and is equipped with the necessary up-to-date motor driven tools to build and repair the metal patterns, molding machines and other machinery used throughout the foundry. In another bay, 140 ft. x 50 ft., is the wood pattern shop on the upper floor, equipped with motor driven, automatic start and stop planer, joiner, pattern grinder, saw tables, band saw, lathe, and revolving oil stone. On the ground floor of this building is a well arranged locker room, lavatory and swimming pool for the convenience of the employees.

The town of Bettendorf now has a population of about 1,500 people, and is to a large extent under the control of the Bettendorf Axle Company, through a town improvement company. This company under franchises obtained from the town council has put in a system of water works to supply the town from an artesian well and a stand pipe located on a bluff. The improvement company also supplies electric light to the town and private houses, the current being obtained from the shop engine room. It has spent about $100,000 in putting in the water and lighting plants for its employees' homes.

CONTINUOUS ANNEALING FURNACES.

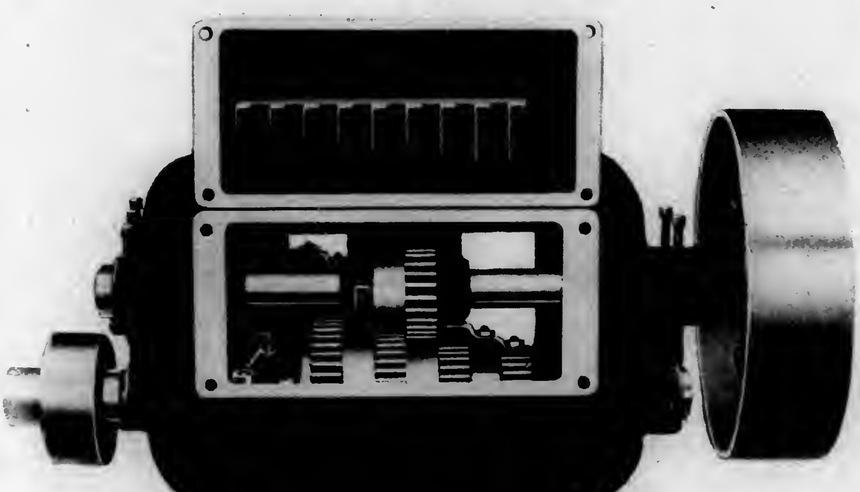
The New York, New Haven and Hartford R. R. has only one circuit for telephone train dispatching, that running from New Haven to Shelburne Falls, involving about 100 miles of wire and 40 stations.

NEW EIGHT CHANGE SPEED BOX

The high development which has been so characteristic a feature of the American Tool Works Company's output in recent years, has been largely the result of a most thorough and persistent effort to include in the re-design and betterments of existing machines every possible detail which might have any influence on the future utility of the finished product. To this end the several parts have been made the subjects of many elaborate tests, and more research has been in evidence toward securing the desired ends than it might well be believed would be devoted to a component mechanical part, and one already of proved efficiency. Nevertheless this exactitude has been exercised; and it is safe to assert that in the present output of this company the various details represent all that long experience and mechanical skill can dictate, a fact well borne out by the elegant and substantial appearance of the machine tools, and their immunity from adverse criticism.

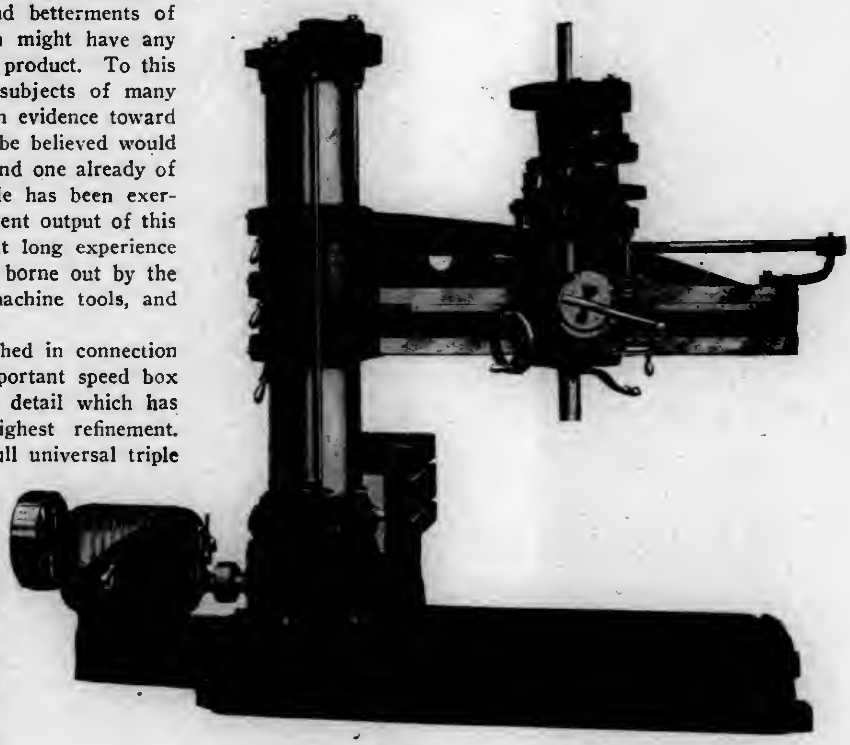
In reviewing just what has been accomplished in connection with improving the various parts the all important speed box stands out prominently as an example of a detail which has been brought by this firm to its very highest refinement. Applied to the 4, 5, 6 and 7 ft. plain and full universal triple geared radial drill, as herein illustrated, it represents a development in this construction which will probably stand unique for some time to come.

Although the speed box mechanism is of very simple construction, which was in fact the feature particularly aimed at by the designers, the power is nevertheless such that it will enable a 6 ft. American radial drill to pull an 8 in. pipe tap. A compound tumbler gear is employed to obtain the speed changes, and this in connection with four gears on the cone provides 8 changes by means of only 7 gears. These changes, in connection with the triple-geared head mechanism, makes provision for 24 spindle speed. These speeds may be easily changed without shock to the driving mechanism, as the cone gears are kept rotating while changing speeds by means of an auxiliary drive between the pulley and cone shafts which is automatically engaged and disengaged by the raising and lowering of the tumbler lever when changing from one speed to another. This auxiliary drive is positive in its action, and is operated through a friction clutch which may be adjusted as required. The auxiliary drive is used only in making speed changes.



TNE NEW EIGHT-CHANGE SPEED BOX.

The tumbler lever is located in its various positions by a notched plate, which prevents the gears from being improperly engaged and also prevents the shifting of the tumbler lever until the auxiliary drive is thrown into operation. After the tumbler lever is located it is securely locked in its position by a latch and locking pin, thus preventing the tumbler gear being thrown out of mesh under heavy strains, and also preventing destructive vibration and rapid wear of the gears with the consequent noise and loss of efficiency.



APPLICATION OF SPEED BOX TO RADIAL DRILL.

All driving gears in this design are made from a special grade of steel carbonized and hardened, and are cut with Brown and Sharpe 20° involute cutters, which form a pointed tooth. This has been found to be the only proper and satisfactory tooth to use in a tumbler gear mechanism, as it permits engaging the gears without shock or clashing. To guard against the former an absorber in the line of drive takes care of all shocks and strains, thus insuring long life to the driving mechanism.

This style of box is readily interchangeable with the four-step cone pulley regularly furnished, and an American radial, equipped with this drive, can be easily converted into a motor driven machine at any time.

THE NEW HAVEN ROAD has for some time employed the staff system between Middletown and Cromwell, Conn., and is now making use of it in Rhode Island. It is a development of the old-time English staff, which from the earliest days of railroading has been employed.

ACCORDING TO THE GOVERNMENT REPORTS, there is a need for railroad ties in Chile, as there is a requirement this year for 100,000 ties with a pronounced scarcity.

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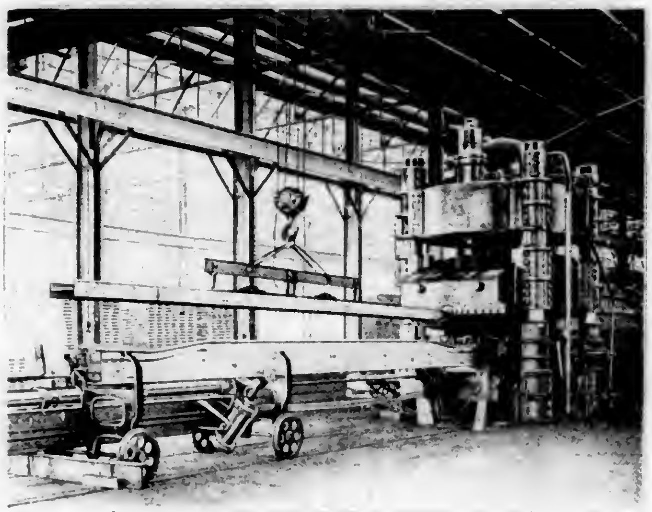

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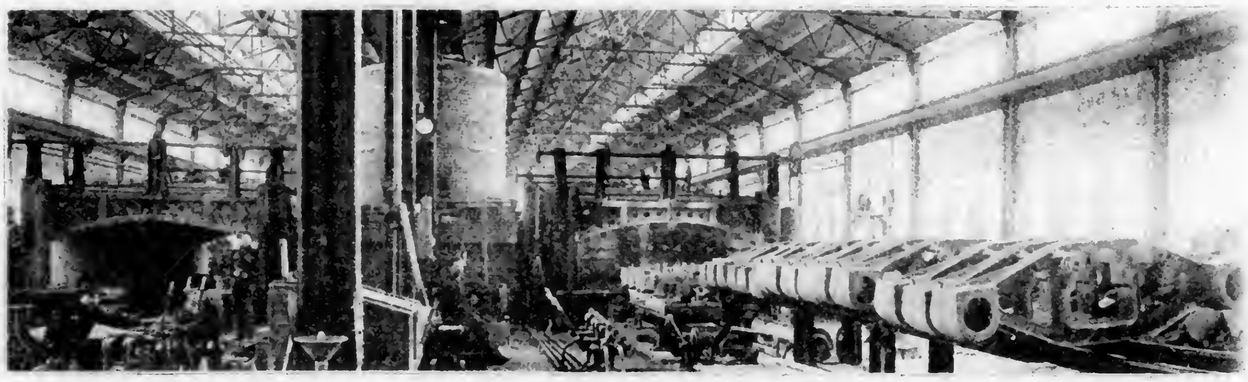

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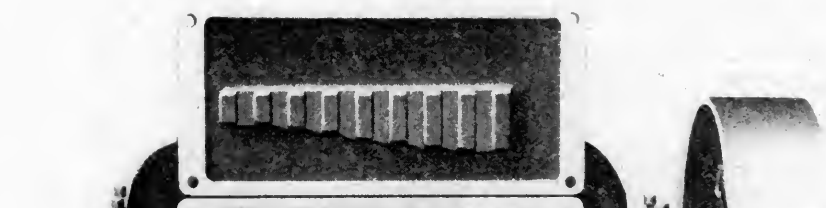

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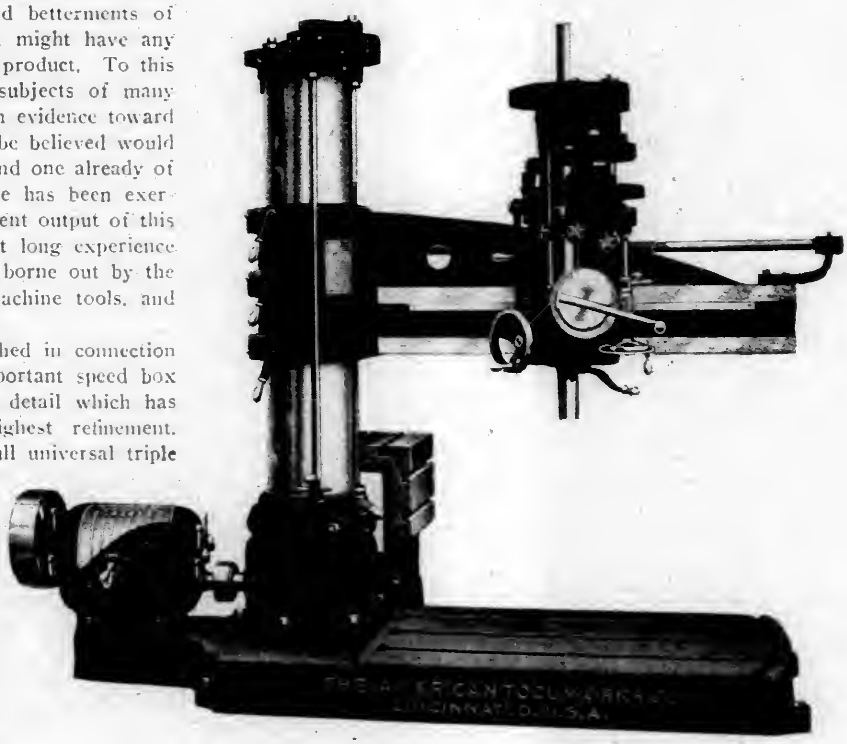


APPLICATION OF SPEED BOX TO RADIAL DRILL.

lever is located it is securely locked in its position by a latch and locking pin, thus preventing the tumbler gear being thrown out of mesh under heavy strains, and also preventing destructive vibration and rapid wear of the gears with the consequent noise and loss of efficiency.

All driving gears in this design are made from a special grade of steel carbonized and hardened, and are cut with Brown and Sharpe 20° involute cutters, which form a pointed tooth. This has been found to be the only proper and satisfactory tooth to use in a tumbler gear mechanism, as it permits engaging the gears without shock or clashing. To guard against the former an absorber in the line of drive takes care of all shocks and strains, thus insuring long life to the driving mechanism.

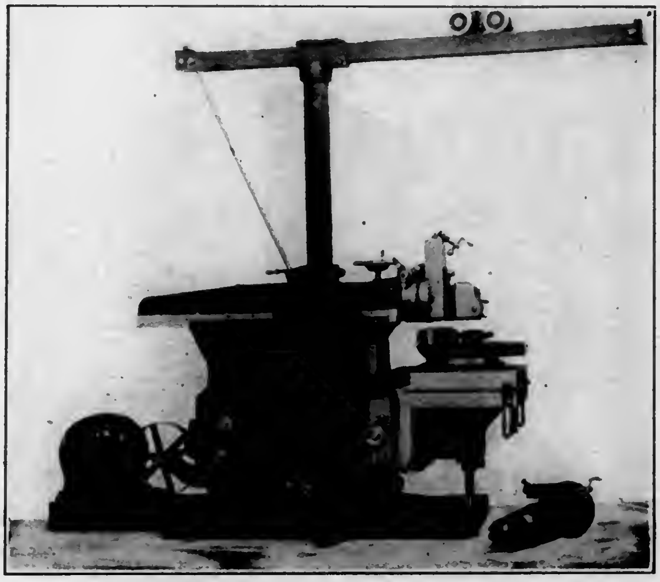
This style of box is readily interchangeable with the four-step cone pulley regularly furnished, and an American radial, equipped with this drive, can be easily converted into a motor driven machine at any time.

The New Haven Road has for some time employed the staff system between Middletown and Cromwell, Conn., and is now making use of it in Rhode Island. It is a development of the old-time English staff, which from the earliest days of railroading has been employed.

According to the Government Reports, there is a need for railroad ties in Chile, as there is a requirement this year for 100,000 ties with a pronounced scarcity.

THIRTY-TWO INCH BACK GEARED CRANK SHAPER

The accompanying illustration shows a 32-inch "Cincinnati" heavy duty back geared crank shaper, recently shipped by the Cincinnati Shaper Co., which is of particular interest on account



CINCINNATI SHAPER WITH JIB CRANE.

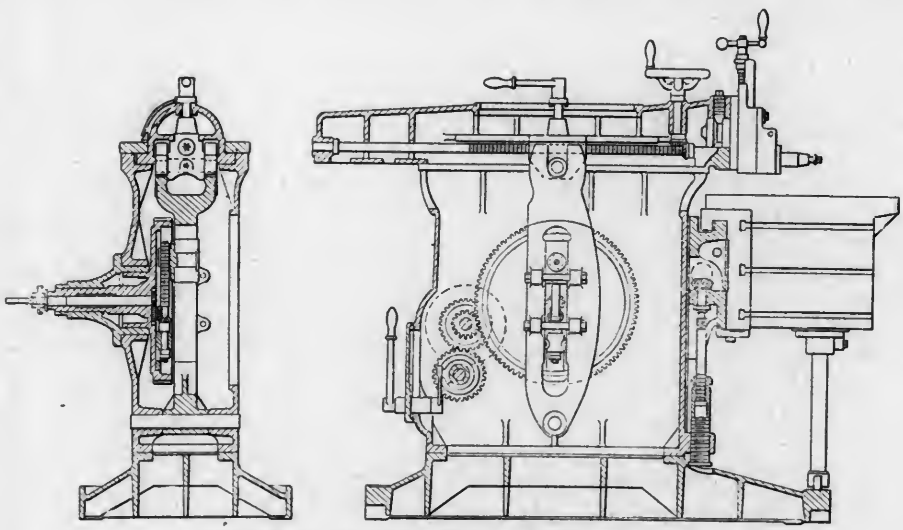
of the equipment which accompanied it. This latter included a constant speed motor of ten horse-power, belt driven through the gear box; a draw cut head, with power driven concaving attachment, as well as an extended circular feeding head, operated by both hand and power feed; a special knee table with tilting top, the top being 30 in. long and 24 in. wide; and a revolving jib crane of 1,500 lbs. capacity. The height of this crane is 9 ft., and due to this the illustration does not adequately convey the proper size of the machine, the weight of which is 9,370 lbs.

This shaper, which has the widest range for both light and heavy work possible to secure in this tool, has been designed with ample power, but the fact has not been overlooked that it must have the necessary rigidity to withstand the peculiar and excessive strains to which it is subjected. The system of jigs and the various tests to which the parts were subjected both in the manufacturing and in the finished machine, have secured accuracy, and the whole results in as perfect a tool as the state of the machinists' art permits.

To give an intelligent idea of this machine sectional views are given which clearly illustrate the design. As will be noticed in the vertical section through the center of the crank wheel or main gear, the journal of this gear has two diameters; the purpose, and one admirably accomplished, being to obviate any possibility of breaking at the junction of the gear. A very prominent point, also, is the close proximity of the rocker arm to the face of the gear, made possible by the crank block, together with its adjusting mechanism, being set well into the face of the gear, thus avoiding the usual overhang. Another particularly appealing feature is the dish-shaped form of the side of the column, which of a necessity bears all of the working strains of the machine, and the internal braces to the dish. The back gears, which are of the sliding gear type, with the four-step cone, or gear box, afford eight cutting strokes to the ram. The ratio of gearing is such that with the size of the cone pulley, this probably becomes the most powerful shaper of its stroke on the market.

The details of the machine are of much interest, and all material entering into its construction is of the highest class. All shafts are of high point carbon steel, and all are accurately ground, and all shaft bearings are amply large. The flat sliding surfaces, as well as the surfaces between the apron and the table are hand scraped to surface plates. The pinions are of cast steel, and all mitre gears are cut from solid bar. The rail is deep, heavy, ribbed horizontally, and strongly gibbed to the column; the cross traverse screw is provided with a graduated collar reading to .001 in., and a variable automatic feed, which is changeable from nothing to full feed while the machine is running. Ball bearings are provided for the elevating screw under the rail, and the screw, of telescopic form, is out of the way of falling chips.

The head swivels to any angle, and is graduated; the locking device is simple and highly efficient, and the down feed screw is provided with a graduated collar, reading to .001 in. There are full length taper gibs throughout, adjustable endwise by single screws; viz., for the ram, head, rail apron and crank wheel slides, affording metal contact on both sides of the gib. This, while a more expensive construction, is said to be preferable to gibs with set screws impinging with varying pressures at the several points in the length of the gib.



SECTIONS OF 32-INCH BACK GEARED CRANK SHAPER.

AMERICAN RAIL JOINTS are used extensively in England, Germany, France and Russia, and the value of the shipments runs into many millions annually.

OLD VARNISH MAY BE REMOVED from a metal surface by dipping it in equal parts of ammonia and 95 per cent. alcohol.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Apr. 4	Team Work in Transportation	C. Murphy	Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	May 12			H. D. Vought	95 Liberty St., New York
New England	Apr. 11	Compensating Employees for Industrial Accidents	James A. Lowell	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Apr. 21	Reinforced Concrete for Railroad Work	J. P. H. Perry	H. D. Vought	95 Liberty St., New York
Pittsburg	Apr. 28	Development of the Locomotive Tube—Its Use and Abuse	F. N. Speller	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Apr. 14	Education and Transportation	F. W. Duke	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Apr. 14			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	Apr. 17			Jos. W. Taylor	390 Old Colony Bldg Chicago
Western Canada	Apr. 10	The Industrial Use of Luminescence	J. W. Dorsey	W. H. Rosevear	100 Chestnut St., Winnipeg, Man.

FUEL ECONOMY.

WESTERN CANADA RAILWAY CLUB.

This timely subject was discussed at the club meeting, February 13, following the presentation of a paper by T. Duff Smith, Fuel Agent of the Grand Trunk Pacific Ry. Mr. Duff considers the kernel of the whole question of fuel economy to rest with the motive power department, or especially with the road foreman of engines, in seeing that the firemen use the coal intelligently and economically, and discussed his subject largely along these lines.

SOME ASPECTS OF THE RAILWAY OF TO-DAY.

RAILWAY CLUB OF PITTSBURG.

At the January 27 meeting of this club the above subject was ably presented by H. W. Thompson, Supt. Pennsylvania Lines west of Pittsburgh. The author discussed the various questions of the hour; competition, consolidation, the merits of Federal and State control of railroads, rebates and many other associated topics at some length and in a manner which rendered his contentions most convincing. The paper was well received and was accorded an animated discussion.

Future meetings of this club will be held at the Monongahela House instead of the Fort Pitt Hotel.

SIGNALING PRACTICE ON STEAM ROADS.

CANADIAN RAILWAY CLUB.

At the meeting on March 7 of this club, L. R. Clausen, Division Supt., Chicago, Milwaukee and St. Paul Ry., presented a paper on the above subject which was received with exceptional favor as a timely and valuable contribution to existing literature on the subject. After a brief historical review of signaling the author considered the work of the Signal and Maintenance of Way Associations at some length before proceeding with an analysis of the functions of the various signals now in vogue. The utmost practicable simplicity in railway signaling was advocated, and letters supporting this view from various operating and executive officers were read by Mr. Clausen as the conclusion to his able paper.

CHARACTERISTICS OF BRITISH RAILWAYS.

NEW ENGLAND RAILROAD CLUB.

One of the most instructive papers which have been presented before the railroad clubs for a long period was that by William J. Cunningham, Assistant Professor of Transportation of Harvard University, read at the meeting of this club on February 14. Mr. Cunningham has recently returned from a tour of observation on the lines of the British Isles, and has accumulated a wealth of data and statistical matter which on this occasion was presented in a most interesting manner, and was highly appreciated by the large attendance. The author divided his general subject into several heads: capitalization, organization, passenger train service, characteristics of passenger equipment, freight service, and locomotives, and each was discussed in a masterly manner which evinced thorough familiarity with the various details. Mr. Cunningham found several things to criticise, as might be expected when comparison was drawn with United States practice, but on the whole the tenor of his paper was quite favorable to British practice and served to throw light on much imperfectly understood procedure. The value of the address was enhanced by a large number of lantern slides of cars, locomotives and shops, from photos made by the author while on his trip.

CAR AND ENGINE EQUALIZERS.

NORTHERN RAILWAY CLUB.

H. Van Dyken, of the Duluth and Iron Range Ry., at the January 28 meeting of this club read a paper on the above subject in which the rather startling suggestion was offered that all spring rigging, springs, saddles, equalizers, hangers, pins, and gibs be done away with. The contention was advanced by the author that these parts fall short, or, in fact, fail altogether, in performing their true functions, and he offers the following as a more advantageous arrangement: the top rail of the main frame to be made hollow, and pumped full of zero car oil on which the engine rides; over the center of each driving box to be a perpendicular hole four inches in diameter, and in the latter to be pressed a quarter inch brass bushing. In this bushing a plunger standing on the driving box is to work, and is intended to impinge on the oil, thus securing perfect equalization at all times for all drivers. The paper was received without discussion.

ELECTRIFICATION OF STEAM RAILROADS.

NEW YORK RAILROAD CLUB.

The seventh annual electrical night of this club was in many respects the most successful one of the series. It was given up chiefly to reports of railroad officials on the operating features of electrified steam railroads and a report by Prof. George F. Swain of Harvard University, a member of the Massachusetts Joint Board on Metropolitan Improvements, on how this board has considered the problem of electrification as applied to Boston and its suburbs. This was a most excellent clean-cut discussion of the whole problem of electrification of suburban lines as they exist in Boston and clearly traced the line of reasoning which led the majority of this board to advise against compulsory legislation on this subject. Prof. Swain's remarks will be largely republished in the next issue of this journal.

A communication from James A. McCrea, general superin-

tendent of the Long Island Railroad, pointed out the many advantages which experience had proven the multiple unit system of control to have in heavy suburban traffic. At present this company has 164 miles of track operating electrically and during its five years' service there has been but one serious delay which could be charged to electrical equipment. Mr. McCrea stated that electrical operation had increased the suburban limits from 24 to 30 miles. He also stated that the multiple unit system makes it possible to handle eight or ten trains per hour per track at a terminal, this being largely due to the decreased amount of switching required. H. Gilliam, electrical superintendent of the New York, New Haven & Hartford, stated that in operating over the 33½ miles from the terminal, current was used for only 12 miles, or during the fifty minutes required for covering this run, current was on for only seventeen minutes. Steam locomotive engineers can successfully operate electric locomotives after a few hours' instruction per day for two weeks.

W. S. Murray, electrical engineer of the New York, New Haven & Hartford Railroad, is strongly in favor of the single-phase system for trunk line service under any condition. This company now has 100 miles of single track electrified and has under way the electrification of over 372 miles. He stated that the average delay for all electrically operated trains on the New Haven Railroad were such that a train could cover a distance equal to that from New York to San Francisco and return eleven times with a delay of but one minute.

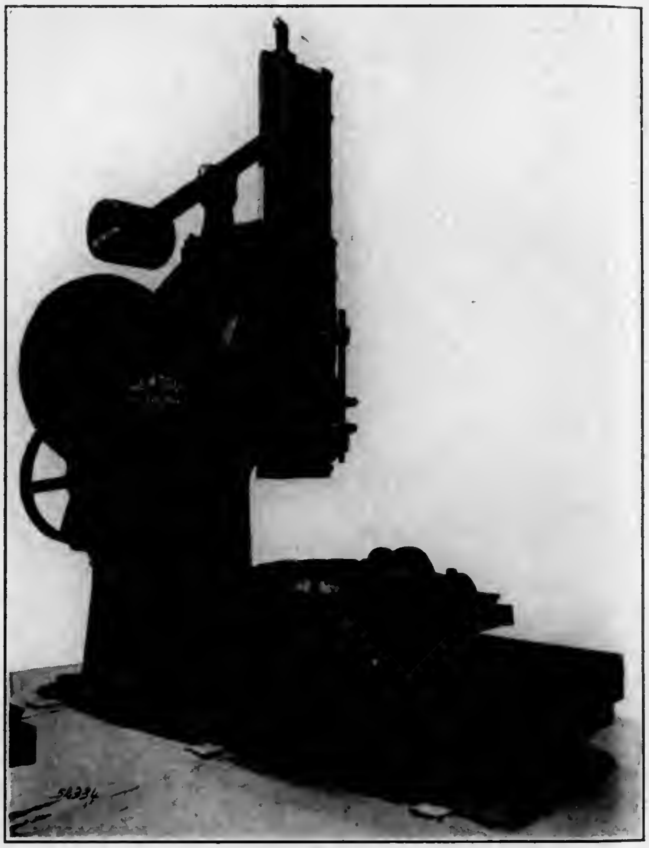
Other members speaking on the subject in general were Wm. McClellan, a member of the club's committee on electrification; W. B. Potter and A. H. Armstrong of the General Electric Co., the latter stating that the New York Central electric locomotives run from 1,200 to 1,300 miles between inspections.

TWENTY-FOUR INCH CRANK SLOTTER

In pursuance of its policy to make an annual redesign of many machine tools embodied in its output, the Newton Machine Tools Works Co., of Philadelphia, Pa., has included therein its line of crank slotting machines, the 24 in., or maximum size of which is illustrated herewith. This machine is of the same design from and including the 15 in. size up. A consideration of the principal dimensions and constructive details is of interest and will illustrate the refinement which machine tool design has attained in producing a compact and exceedingly powerful tool without the cumbersome features so generally associated with slotters.

The maximum stroke is 24 in.; minimum distance from the bottom of the tool holder to the work table, 3½ in.; maximum distance from the bottom of the tool holder to the work table, 47½ in.; minimum distance from the bottom of the cutter bar guide to the work table, 8 in.; maximum distance from the bottom of the cutter bar guide to the work table, 24 in., and distance from the front face of the tool slide or holder is 36 in. The work table is 40 in. in diameter over the working surface, and there is available 48 in. of in-and-out motion to the cross saddle, and 48 in. of adjustment of the circular saddle on the cross slide.

The machine occupies a floor space of 11 ft. 7 in. by 48 in. on the base, and the over-all length of the cross saddle is about 8 ft. The cutter bar has square locked gibbed bearings in the guide, is counterweighted, and carries a relief tool apron with vertical and horizontal steel faced clamping surfaces with necessary clamps. It is arranged for elevation to suit the varying lengths and heights of work, and the face of the bar is grooved, into which corresponding tongues on the yoke washer fit, to relieve the stroke adjusting screw of strain when taking cuts. The side adjustment of the bar in the guide is made by a continuous taper shoe which is considered a very great advantage over the former method of using an English shoe having elongated holes, and the adjustment made by set screws. The counterweight arm is forged of steel; the cutter bar guide is of very heavy construction; has square locked gibbed bearings to the frame, and is adjustable by hand to support the bar when cutting in its lowest positions. The face of the crank plate is grooved, and corresponding tongues on the connecting rod fit into these grooves to relieve the stroke adjusting screw when taking cuts. The bearing or trunnion for the large driving plate gear is cast solid with the frame, and the drive is by means of motor or four-step cone through Whitworth motion, giving quick return to the stroke.



HIGHLY DEVELOPED HEAVY SLOTTER.

The work table is of very heavy construction with ample clamping facilities, and has a large circular bushed bearing in the cross slide, and the table is surrounded by an oil pan, the top edge of which serves for a bearing for the continuous circular shoe. The rotating worm wheel is cut from the solid and the table is indexed with a pointer mounted in a small slot. Adjustment of the circular table saddle to the cross slide is made by means of taper shoes, and the cross saddle has square locked gibbed bearings to the base. A distinct departure in this type of machine is, that the in-and-out feed screw remains stationary and the adjustment is obtained by a combination bevel gear and nut, which gives a very substantial construction, and permits of a bearing on each end of the adjusting screw. There is provided variable reversible automatic power feed to the circular, cross, and in-and-out movements, in addition to hand adjustment. The approximate net weight of this machine arranged for motor drive without the motor, or for belt drive without the countershaft is 30,000 pounds, so that it can be realized that this machine is of exceptionally heavy construction; in fact, the engineers of equipment from the different railroad companies and manufacturing plants advise that these machines are heavier than necessary for any service that is liable to exist, although they are flexible in operation on account of the concentration of the levers of control.

PERSONALS

E. M. Sanjule has been made roundhouse foreman of the Santa Fe at Gallup, N. M.

Frank H. Kaub, said to be the first master mechanic of the Union Pacific R. R., died recently in Denver, Colo., at the age of 78 years.

Wm. Stapp has been made general car foreman at La Junta, Colo., on the Santa Fe, succeeding D. Hurley, transferred to Topeka, Kans.

W. Q. Daugherty has been appointed master mechanic at Jackson, Tenn., on the Mobile and Ohio R. R., to succeed G. L. Lambeth, transferred.

F. J. Smith has been appointed master mechanic for the Chicago Great Western Ry., with headquarters at Stockton, Ill., succeeding J. M. Robb, resigned.

J. E. Roberts has been made machine foreman of the Big Four shops at Beech Grove, Ind., and J. Martin succeeds Mr. Roberts as tool foreman at that point.

W. J. Mayberry has been made general foreman of the Trinity & Brazos Valley R. R. at Tomball, Tex., vice F. P. Cleaver, resigned to accept service at Portland, Ore.

E. J. McMahn has been made general foreman of the Santa Fe at La Junta, Colo., vice M. M. Myers, resigned to accept a position with the Missouri Pacific Ry.

A. Stewart, general superintendent of motive power and equipment of the Southern Railway, has had his authority extended over the Virginia & Southwestern Ry.

F. H. Greene, general purchasing agent of the New York Central Lines, at New York City, has resigned to become president of the Hale & Kilburn Manufacturing Company, Philadelphia, Pa.

E. E. Booth has resigned as roundhouse foreman of the Missouri, Kansas & Texas Ry. at Wagoner, Okla., to accept a similar position with the Wichita Falls & Northwestern R. R., at Wichita Falls, Tex.

J. H. Bransford has been appointed a general foreman of the Chesapeake & Ohio Ry., with office at Thurmond, W. Va., succeeding Frank J. Walsh, resigned to go to the Chicago Pneumatic Tool Company.

Henry Shulte, assistant road foreman of engines of the west end of the Buffalo division of the Lehigh Valley Railroad, has been appointed road foreman on the same district, with headquarters at Buffalo, N. Y.

John H. Guess, formerly general purchasing agent of the National Railways of Mexico, has been appointed assistant general purchasing agent of the Grand Trunk Railway, with office at Montreal, Que., Canada.

R. L. Doolittle, master mechanic of the Atlanta, Birmingham & Atlantic Ry. with office at Fitzgerald, Ga., has been appointed superintendent of motive power, a new position, and his former office has been abolished.

C. J. Stewart, formerly master mechanic of the Western Division of the New York, New Haven and Hartford Railroad, has been transferred in a similar capacity to the Boston Division, *vice* James Hocking, resigned.

W. H. Graves, formerly general foreman on the Fort Worth & Denver R. R., and first president of the International Railway General Foremen's Association, has been made foreman of the Rock Island Ry. at Liberal, Kan.

G. L. Lambeth, master mechanic of the St. Louis division of the Mobile & Ohio R. R. at Jackson, Tenn., has been appointed master mechanic of the Mobile division at Whistler, Ala., vice E. G. Brooks assigned to other duties.

C. N. Page has been appointed master mechanic of the Lehigh Valley R. R. at Auburn, N. Y., succeeding J. N. Mowery, resigned. Mr. Page will perform his new duties in connection with his position as trainmaster, which he still retains.

M. R. Smith, master mechanic in charge of terminals of the Chicago, Indianapolis & Louisville R. R., at Lafayette, Ind., has been appointed shop master mechanic, with office at Lafayette, succeeding O. S. Jackson, resigned to go to another company.

T. A. Lawes, master mechanic of the Chicago, Terre Haute & Southeastern Ry., at Terre Haute, Ind., has been appointed mechanical engineer of the New York, Chicago & St. Louis R. R., with office at Cleveland, Ohio, succeeding L. B. Morehead, resigned.

J. N. Mowery, who recently resigned the position of master mechanic at Auburn on the Lehigh Valley Railroad, has been appointed master mechanic of the Western Division of the New York, New Haven and Hartford Railroad, with headquarters at New Haven, Conn.

A. S. Abbott, formerly division master mechanic at Fort Smith, St. Louis and San Francisco R. R., has been transferred to Sapulpa, Okla., as division master mechanic in charge of the Southwestern division and the Creek and Sherman sub-divisions of the Red River division.

H. E. Creer, general car foreman of the Missouri Pacific R. R. at Atchison, Kan., has resigned to become mechanical expert for McCord & Company, Chicago, succeeding the late D. J. McOscar, who died on December 22, 1910. Mr. Creer's headquarters will be in Chicago.

G. J. Duffey, assistant master mechanic of the Lake Erie & Western Ry., the Fort Wayne, Cincinnati & Louisville Ry., and the Northern Ohio R. R., at Lima, Ohio, has been appointed master mechanic, with office at Lima, succeeding F. H. Reagan, resigned.

John F. Ensign, of Colorado, has been appointed by President Taft to be chief inspector of locomotive boilers in accordance with the new law just adopted by Congress. Frank McManany, of Oregon, and G. P. Robinson, of New York, have been chosen to be assistant chief inspectors in the West and in the East respectively.

William Henry, division master mechanic of the St. Louis & San Francisco R. R. at Sapulpa, Okla., has been transferred to Monett, Mo., as division master mechanic in charge of the Kansas and the Western divisions, succeeding Frank Burns, who has been transferred to Fort Smith, Ark., in charge of the Central, the Arkinda, and the Ardmore sub-divisions of the Red River division.

A. C. Adams has resigned as division master mechanic on the New York, New Haven and Hartford R. R. to become superintendent of motive power of the Spokane, Portland and Seattle R. R., with office at Portland, Ore. He will have charge of the maintenance of motive power, machinery and equipment, and conjointly with the general superintendent, the operation of the rolling stock. Mr. Adams has also been appointed superintendent of motive power of the Oregon Electric and the United Railways Co., with office at Portland, Ore.

Paul Raymond Brooks, formerly on the staff of the *Railway Review*, died at the home of his aunt in Chicago on March 11. Mr. Brooks graduated from the Massachusetts Institute of Technology in 1900, and after serving four years as a special apprentice on the Chicago, Burlington and Quincy Railroad, went with the Railway Appliance Co. He was later city salesman for the Otto Gas Engine Co. in New York, which position he resigned to become general manager of the Machinery Sales Co. of New York. Later he joined the staff of the *Railway Review*, being attached to the Eastern office, and upon the death of his father, about a year ago, he went to Texas to take charge of the large real estate interests of the family in that State. He was a member of the Amer. Soc. Mech. Engrs., Technology Club of New York, New York Railroad Club and was successively an officer in the Illinois Naval Reserve and the 1st Bat. New York Naval Militia.

CATALOGS

Ball Bearings.—The Hess-Bright Mfg. Co., of Philadelphia, Pa., has supplemented former information on this subject by the issue of two leaflets dealing respectively with rope drive and conveyor sheaves, and annular (radial) bearings.

Rivet Heating Furnaces.—In Bulletin 27 the Rockwell Furnace Co. illustrates a line of portable rivet heating furnaces and miscellaneous furnaces which is of exceptional reference value. The descriptive matter is also enhanced by a page of valuable practical pointers on rivet furnaces and rivet heating.

Locomotive Flues.—Through a leaflet entitled "When a Train is Behind Time," the Detroit Seamless Steel Tube Co., of Detroit, O., points out convincingly the merits of its cold drawn, seamless, open hearth steel locomotive flues, and indicates how through their use flue troubles can be reduced to a minimum.

Engine Type Generators.—The Sprague Electric Co.'s bulletin No. 111 partially lists and illustrates installations of its engine type generators. The half tone work is very good, and although the bulletin does not include descriptive matter, it is of considerable interest in view of the magnitude of the installations represented.

Purdue University.—A recently issued bulletin by this well known university describes and illustrates its shops and engineering laboratories and contains much valuable information in regard to each shop in detail. The various departments and their arrangement are shown in many well executed half-tones, and the scope of the work undertaken therein is fully and carefully explained.

Acetylene Burners.—The American Lava Co. of Chattanooga, Tenn., has just put out a very attractive catalog which will prove particularly attractive to those interested in the general subject of acetylene burners. All styles of the latter as manufactured by this company are fully described and illustrated and it is clearly evident that in the preparation of

the book every effort was made to render the information as complete as possible.

Gas Driven Mining Locomotives.—The Milwaukee gas driven locomotives are described and illustrated in a catalog recently issued by the Milwaukee Locomotive Mfg. Co., of Milwaukee, Wis. These locomotives have been on the market for a number of years and have proved remarkably well adapted for service around industrial plants. The catalog gives a good illustrated description of the machine, and portrays the various types which comprise the output.

Track Motor Cars.—The Burton W. Mudge Co., of Chicago, Ill., has just issued an attractive illustrated circular describing the Adams motor car and its application to railroad work. These cars have a speed anywhere from 3 to 45 miles per hour, and through the sensible distribution and mechanical balance of its 300 pounds weight embodies an unusual factor of safety. The racking motion common to small motor cars is eliminated in its construction, and its easy riding qualities are a most prominent feature.

Journal Box Packing.—The Franklin Mfg. Co., of Franklin, Pa., under the title "Suggestions Relative to the Introduction and Use of Journal Box Packing for Railways," has just put out a very interesting booklet which deals exhaustively with this always important question. It is pointed out that Perfection Packing, as manufactured by this company, has been demonstrated, through extensive experiments in physical and chemical laboratories, to be a packing which adequately meets every essential requirement of railway service, and many valuable truths are embodied in regard to the subject in general.

Monel Metal.—This product of the Bayonne Casting Co., of Bayonne, N. J., is thoroughly described in a recently issued catalog which is complete in all information which might be desired on the subject. A table of the physical properties of Monel Metal is included, which will be of value to those interested. Since the qualities of this metal have become more generally known its field of application has rapidly extended, and it can now be furnished in any of the following forms: castings, rods and bars, sheets, wire, forgings, ingot, and shot. Much valuable matter is included in the catalog in regard to the proper treatment and handling of this metal.

Pedestal Concrete Piling.—Under the title "The Pedestal Pile" the MacArthur Concrete Pile and Foundation Co. of New York, N. Y., has issued a 61-page handsomely illustrated book for engineers, architects, owners and contractors, which describes the pedestal concrete pile, and discusses the relative merits of wooden and concrete piles of various types. The pedestal pile, which is described at some length, is a distinct and radical improvement in piling construction. It differs from the ordinary wood or concrete pile in that a large carrying capacity, in addition to that due to frictional adhesion, is derived from the direct bearing power of a broad base resting in firm and compact subsoil.

Car Ventilation.—This important and timely subject is thoroughly considered in a very attractive catalog recently issued by the Burton W. Mudge Co., of Chicago, and which describes and illusetrates the Garland system of ventilation. The catalogue is replete with handsome half-tones of many prominent trains of the country, in connection with which this system has been adopted. Its application to refrigerator cars is specially featured in the latter part of the book, where eight pages are devoted to descriptive matter and illustrations which clearly portray the general arrangement and details. The catalog will be found very valuable for reference in view of the general interest which is now evinced in the Garland system.

American Locomotive Co.—The classification, analysis and comparative heating values of different grades of coal forms the subject of "Bulletin No. 1008" which proves to be a most valuable addition to the existing information on the subject. It is shown that locomotives burn, approximately, 100 million tons a year, or one-fifth of the total amount of coal mined annually in the United States. This data and much more of the same interesting character was originally compiled and published in voluminous reports by the United States Geological Survey, and portions of it in condensed form were considered of sufficient interest and value to readers of the American Locomotive Company's bulletins to warrant publication in that form. The tables accompanying the bulletin are of especial value through the concise manner in which the various subjects are epitomized for convenient reference.

Mallet Articulated Locomotives.—Bulletin No. 69, issued by the Baldwin Locomotive Works, constitutes an important addition to the literature on this timely subject. The book is devoted to a consideration of this power as built for the Atchison, Topeka and Santa Fe Railroad exclusively, and for which the Baldwin Works has recently completed an order for forty locomotives of this type. Owing to special features in the construction of these engines, the bulletin describes them in detail, and does not omit mention of the two "flexible boiler" locomotives, Nos. 1158 and 1159, which embody in their design a decided innovation. The flexible boiler connections used on these two engines are entirely different, engine 1158 having a double ball-jointed connection, while engine 1159 has a pleated or bellows form of connection. The details of this novel arrangement are fully described and illustrated in the book, and the information is presented in an attractive form.

NOTES

Carnegie Steel Co.—James J. Dongan, formerly superintendent of the 39th street, Pittsburg, plant of this company, died on March 5. He was 64 years old.

Standard Steel Car Co.—This company is said to be having plans prepared for an addition to its plant at Butler, Pa., but the details of the proposed improvement have not been made public.

National Malleable Castings Co.—In a decision recently rendered by Judge Rellstaf in the United States Circuit Court for New Jersey, the validity of the patents on the Climax coupler was established in favor of this company.

Firth-Sterling Steel Co.—David E. Jackman, of the firm of E. S. Jackman & Co., Chicago-Cleveland-Pittsburg, has withdrawn to accept the position of treasurer with the Firth-Sterling Steel Co. of McKeesport, Pa., and assumed his new duties on April 1.

S. Obermayer Co.—Its New England branch is now located at 44 Stonehurst street, Dorchester, Boston, Mass., with Wm. Fitzpatrick in charge, and any inquiries or orders for foundry facings, supplies and equipment forwarded to that branch will have immediate attention.

A. Eugene Mitchell.—Prof. W. F. Schaphorst, of the mechanical engineering department of the New Mexico College of Mechanical Arts, has resigned his position there to become a technical writer on the staff of A. Eugene Michel, advertising engineer, New York City.

Cincinnati Punch & Shear Co.—Announcement is made by C. J. McDiarmid, trustee in bankruptcy for the above firm, that bids will be received for all its assets up to April 4, 1911, except the accounts and bills receivable. The assets, which may be inspected at the plant, 1422 Plum street, Cincinnati, O., consist of a full equipment of machinery, tools, etc., and about $5,000 worth of finished product ready to ship.

McCord & Co.—H. E. Creer, who was formerly general car foreman of the Missouri Pacific Railroad at Atchison, Kansas, and general car foreman of the Pere Marquette R. R., in charge of the Grand Rapids and Detroit districts, has accepted serice as mechanical expert with McCord & Company, succeeding the late D. J. McOscar, who died of pneumonia on December 22nd last. Mr. Creer's headquarters will be at the Chicago office in the People's Gas Building.

Reliance Electric & Engineering Co.—This company announces removal to new offices and shop on Ivanhoe Road, Cleveland, O. The new plant is of reinforced concrete construction with saw tooth roof, and particular attention has been paid to arrangement, lighting and all other features which tend to manufacturing efficiency. The new quarters afford double the former capacity, and place the company in a position to give motor orders the best possible attention. It is requested that correspondence be addressed to Collinwood Station, Cleveland, O.

Hobart-Allfree Co.—J. Fremont Murphy, mechanical expert, whose office has been in the Hudson Terminal Building, 30 Church street, New York, has associated himself with The Hobart-Allfree Co., 1360 Old Colony Bldg., Chicago, and will devote his entire attention to the Allfree system of steam distribution as applied to locomotives. Mr. Murphy was for many years connected with the American Locomotive Co. as mechanical engineer, and later superintendent of the Cooke Works at Paterson, N. J., and is, therefore, thoroughly conversant with modern locomotive design and methods of construction.

Kennicott Co.—It is announced by this company, of Chicago Heights, Ill., that to provide adequate facilities for its steel car department an extensive addition is being made to its plant and the most modern machinery and appliances are being installed to economically handle heavy steel work. The car department is one of the newer lines of the Kennicott Company, and is becoming a very important part of its business. The department is prepared to handle structural steel freight and passenger equipment, steel underframes for all classes of equipment, steel tank cars complete, steel re-enforcers or strengtheners for wooden equipment, trucks and mine cars and general plate construction.

Suffern & Son.—Announcement is made that a "Department of Effective Organization" under the direction of C. J. Morrison, has been organized to aid in securing the most effective organizations and the most efficient methods in manufacture and business. The work of this department is to obtain the desired ends through the elimination of unnecessary work, expenses or investments, and through turning unproductive into productive factors. Such a study and analysis of business requires special training and experience, and the ability to look at the work from an outside perspective. It demands a close attention which those actively engaged in the business itself can rarely give, and is the kind of service which this new department under Mr. Morrison's direction will without doubt render most satisfactory.

Crawford Underfeed Locomotive Stoker

ON THE PENNSYLVANIA LINES WEST OF PITTSBURGH D. F. CRAWFORD, GENERAL SUPERINTENDENT OF MOTIVE POWER, HAS DESIGNED AND DEVELOPED TO A SUCCESS A TYPE OF LOCOMOTIVE STOKER WHICH FEEDS THE FUEL INTO THE FIRE BOX THROUGH NARROW TROUGHS BETWEEN SECTIONS OF THE GRATE AND UNDERNEATH THE FUEL BED.

When fresh fuel is fed into the firebox the first step in the process of combustion is the distillation of the gaseous or volatile matter. The combustion of these gases, in the case of bituminous coals, produces a large proportion of the heat obtained from the total combustion of the fuel, in fact in some coals it forms the principal source of heat. This volatile matter consists very largely of hydrocarbon gases and for its combustion requires the presence of a sufficient supply of oxygen and a temperature of at least 1,800 degs. When green coal is thrown on top of a bed of fire these gases, which are distilled off very rapidly, must be supplied with the necessary oxygen, either through openings above the fire level, as for instance the fire door, or excess of air passing through the fuel bed. Further, the area of the firebox above the fuel bed must have a temperature of at least 1,800 degs. to produce the desired combustion. When most of the air for this combustion is supplied from above the grates the temperature must be decidedly higher in order to neutralize the cooling effect of the entering air. If either one or the other of these conditions is absent the volatile matter passes off practically unconsumed, resulting in smoke and a decided loss of heat.

When green coal is fed to the fire from underneath the fuel bed the gases as they are distilled off by the radiated heat have to pass through the incandescent bed of fuel above, and while on this passage, if the arrangement is proper, they meet the required oxygen coming through the grates and ideal conditions for perfect combustion are present, resulting in a smokeless fire as well as the maximum amount of heat.

The combustion of the coke or residue after the gases have been burned is a much slower process and requires only the assurance of an ample supply of oxygen.

In the development of locomotive stokers in general, practically all of the designs have in a way imitated the action of the firemen by feeding the fuel on top of the fire bed. If this is done properly complete combustion will take place the same as occurs when a skilful fireman is at work. It has been found with several stokers of this type, however, particularly when in the hands of men who were not skilful firemen with the shovel, and even under certain conditions with expert handling, that considerable smoke will be formed at various times, indicating incomplete combustion.

In view of this and the results obtained by underfed stokers in stationary practice, D. F. Crawford, in developing a stoker on the Pennsylvania Lines West of Pittsburgh, became convinced that for the most satisfactory results under all conditions of handling, the underfed principle was the proper one. He also believed that the stoker should not only feed the fuel into the firebox, but that it should handle it directly from the tender without the necessity of the fireman's assistance. After several years' study and experiment along these lines the stoker and conveyor shown in the accompanying illustration has proved to be a most gratifying success in actual service. This result has been obtained by a steady and constant development in the application of the principle, and while the machine as now designed is beyond doubt successful, it is not felt that it will not be found capable of further refinement and improvement. At the present time it has been fitted to several locomotives which have been in regular service for a year or more without any serious trouble with the stoker.

From the beginning it was believed by the designer that the stoker on a locomotive should not interfere in any way with the fireman feeding the coal with the shovel in the customary manner in case of the machine getting out of commission for any reason or where it might be necessary to assist the stoker with hand firing. He also felt that the whole design should be marked with the utmost simplicity, that the mechanism should be strong and rugged and contain as few parts as possible. The Crawford stoker is remarkable in both these respects.

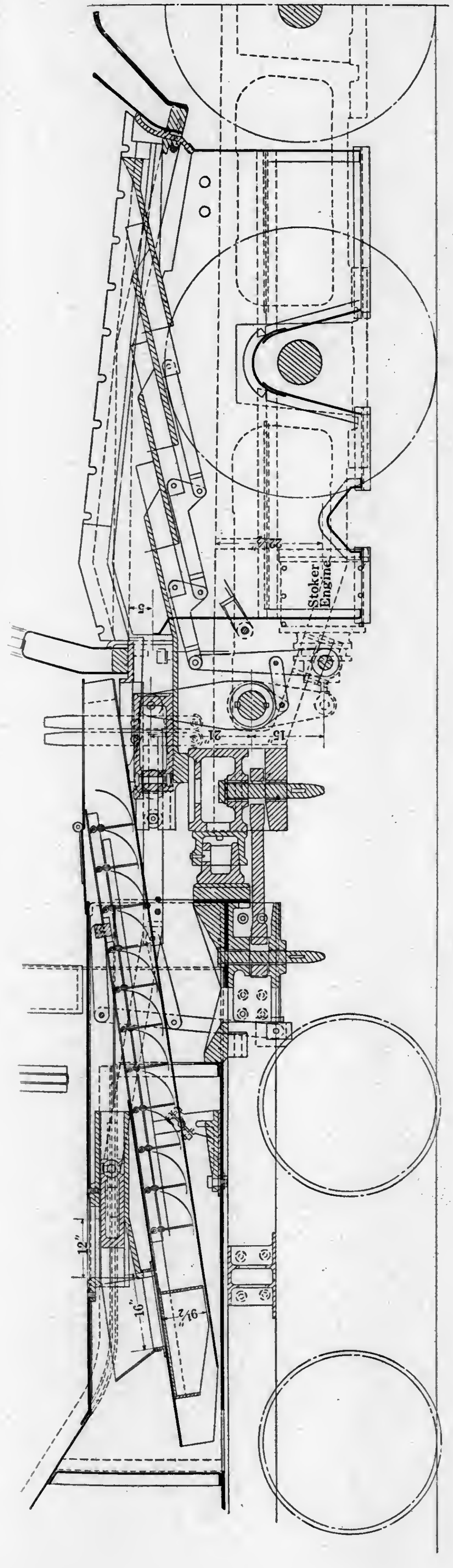
In the cab the only thing outside of the firebox to indicate the presence of a stoker are two small covered hoppers rising about 4 in. above the deck, close to the boiler head. Everything else is out of sight and out of the way. Its simplicity is evident from the drawings.

In general arrangement the stoker consists of two troughs secured under the mud-ring, their upper edges slightly above the level of the grates. These cast iron troughs are about 9½ inches in width and 20 in. in depth at the back end and shallow up to no depth at the front end of the grates. The green coal is forced into each by an 8 in. reciprocating plunger located back of and just below the mud ring. It is further distributed toward the front end by three small plungers spaced along the bottom of the trough at the proper inclination to force the coal forward and upward to gain the most satisfactory distribution. All of the plungers in the bottom work in unison and opposite to the main plunger. They are all connected through links, as shown, to a crank on the main operating shaft, which extends across and is carried in bearings bolted to the frame. This shaft receives its motion from a steam cylinder secured outside of the frames on the left side. The main plunger has its connection to an arm on the opposite side of the shaft.

The steam cylinder has a diameter of 15 in. and a 12 in. stroke and is fitted with a regular top head valve gear of the Westinghouse 9½ in. air pump, the reversing rod of which extends down through a cored passage in the trunk piston employed. This cylinder provides power and movement for all parts of the stoker, including the conveyor, and its steam supply is controlled by a globe valve on the fireman's side of the cab.

The conveyor extends from below an opening in the floor of the tender on a slight inclination upward to the discharge over small hoppers above the main plunger of the stoker. It is of the reciprocating type and includes a combined increment loader and crusher working just below the opening in the tender floor. This rectangular plunger receives its motion through a link connection from the arm on the main operating shaft that give the motion to the main stoker plunger. The coal from the tender drops through the opening in the floor in front of this loader and crusher and is discharged into a trough about 9½ in. in depth and 18 in. wide. Over this is a reciprocating frame carrying a series of hinged fingers, arranged to have free movement forward of the vertical position, but prevented from moving back of it. As this frame reciprocates, being connected through links to the same arm that operates the loader, the fingers slide over the top of the coal on the backward stroke and dropping down move the fuel forward in the trough on the forward stroke, eventually discharging it in front of the main stoker plunger, which working in unison with them is in proper position to receive the charge and on the return stroke to force it into the trough. Although there are two troughs and plungers, there is but a single conveyor, the discharge being arranged so that half of the coal brought up drops in front of either plunger.

THE CRAWFORD UNDERFEED LOCOMOTIVE STOKER AND ITS CONVEYOR.

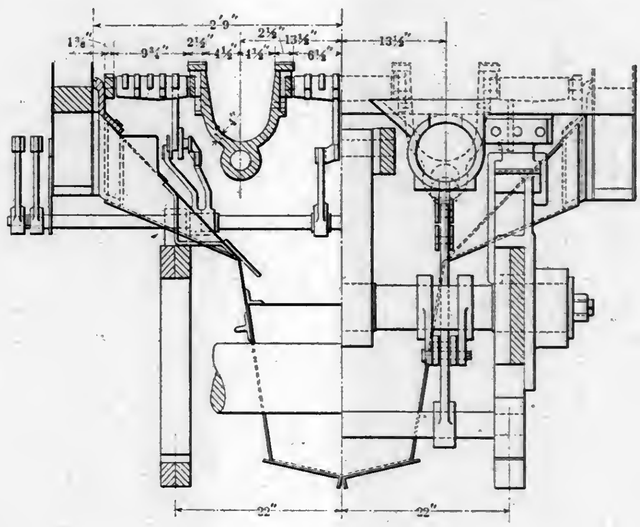


SECTIONAL ELEVATION OF CRAWFORD STOKER AND CONVEYOR. THE EXTREME SIMPLICITY IS VERY NOTICEABLE.

The conveyor while secured to the locomotive to prevent any movement in its relative position to the stoker is really a tender appliance and it is carried on the tender by means of a support arranged to give free movement in both the horizontal and vertical planes while at the same time maintaining its position in the proper relation with the loader. This is arranged by supporting the trough at a point about one-third the distance from the back end by trunnions resting in a casting, which is secured by means of a pivot to the tender frame at a point about 12 in. back of the conveyor support. The motion for the reciprocating fingers is arranged through a series of links so that the relative position of the engine and tender does not affect it.

Providing for a possible failure of the conveyor apparatus there are two small hoppers extending slightly above the deck level discharging in front of the main stoker plungers, through which coal can be shoveled and handled by the stoker in the regular manner.

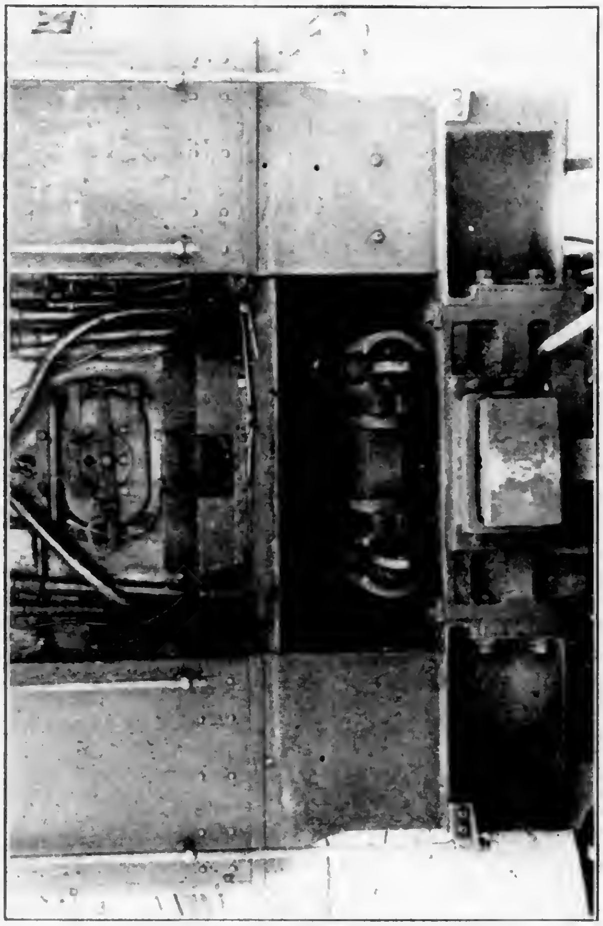
In operation, the coal, crowded into the trough by means of the main plunger and carried forward and upward by the auxiliary plungers, rises up and flows over the edges of the trough onto the grates at either side. While there is a slight ridge

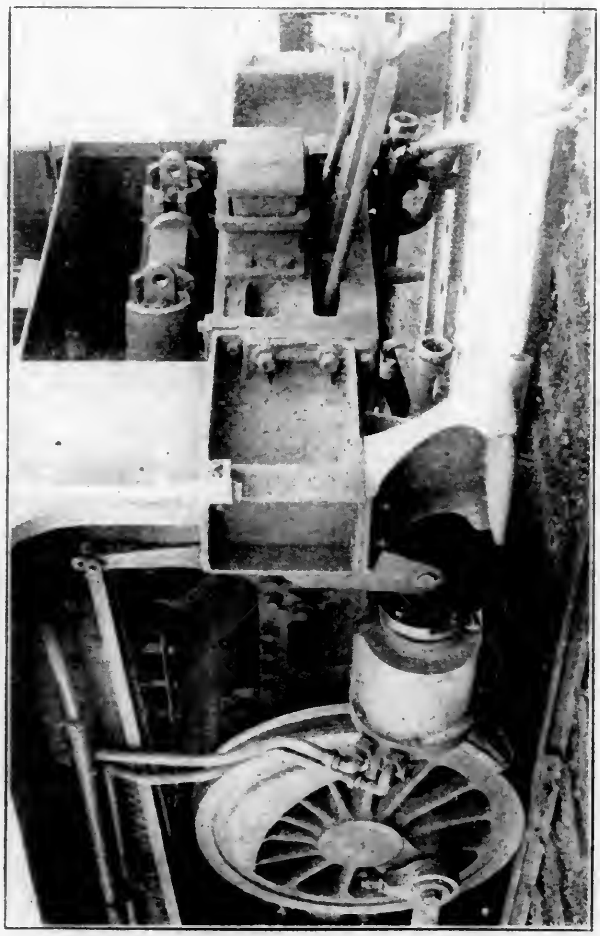


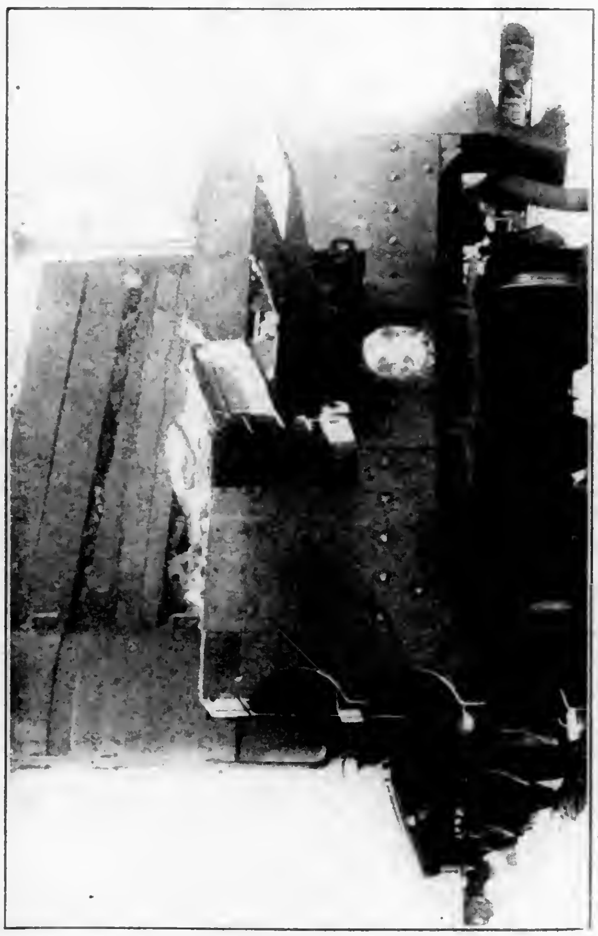
SECTION SHOWING SHAPE AND SIZE OF TROUGHS.

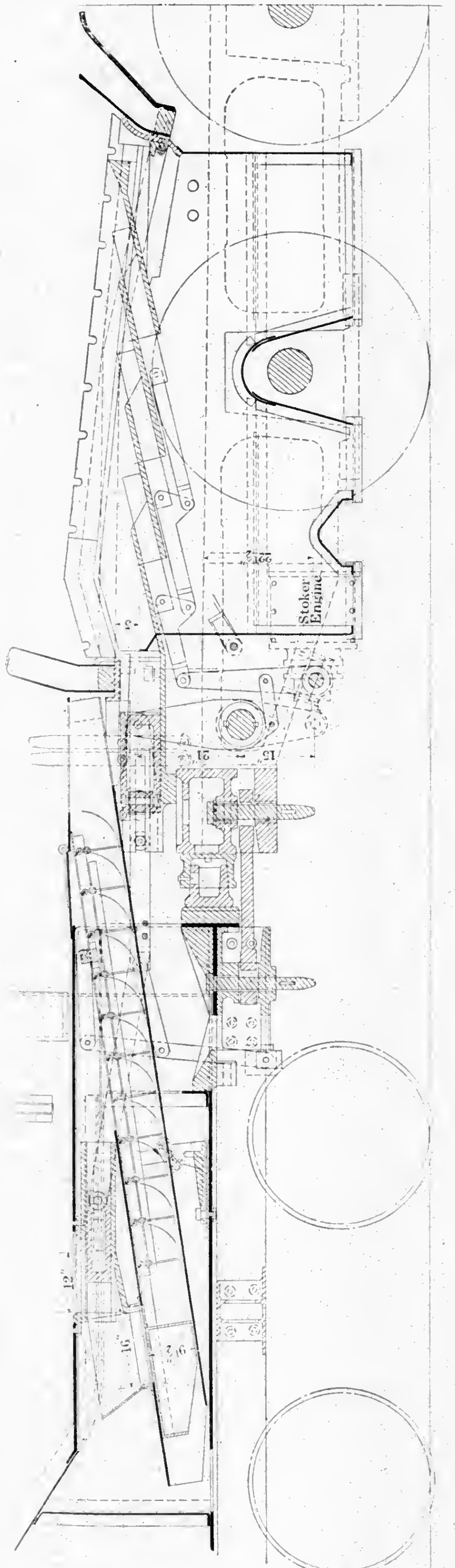
along the top of the troughs when in operation it is not as noticeable as might be expected, since the motion of the engine and the incline of the side of the trough tends to keep the fuel bed fairly level. The total air supply is, of course, obtained through the grates, but it is found that the air works its way through the coal on top of the trough, giving active combustion throughout the whole grate area. While it is possible to discover by means of a colored glass that combustion is not quite as rapid in the center over each trough there is no noticeable difference with the naked eye, and so far as area for combustion is concerned there is no loss by the introduction of the troughs. The reduction of the grate area might be expected to have an effect upon the air supply, but when it is remembered that in the ordinary construction there is generally a vacuum in the ash pan it will be seen that if proper openings in the pan are provided the openings in the grate will be more than sufficient. As a matter of fact, in practice and by tests it has been found that the introduction of the troughs has not interfered with a sufficient supply of air through the grates.

In starting, a fire is built in the same manner as with a locomotive without a stoker until sufficient steam pressure has been raised to operate the stoker engine. As soon as this is attained the stoker is started and is used for building up the fire in the roundhouse and continues in service until the end of the run. The grates are shaken on the road in the same manner as with-









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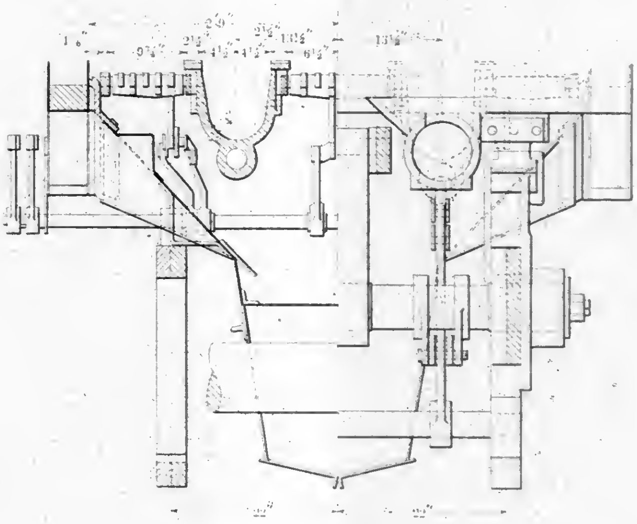

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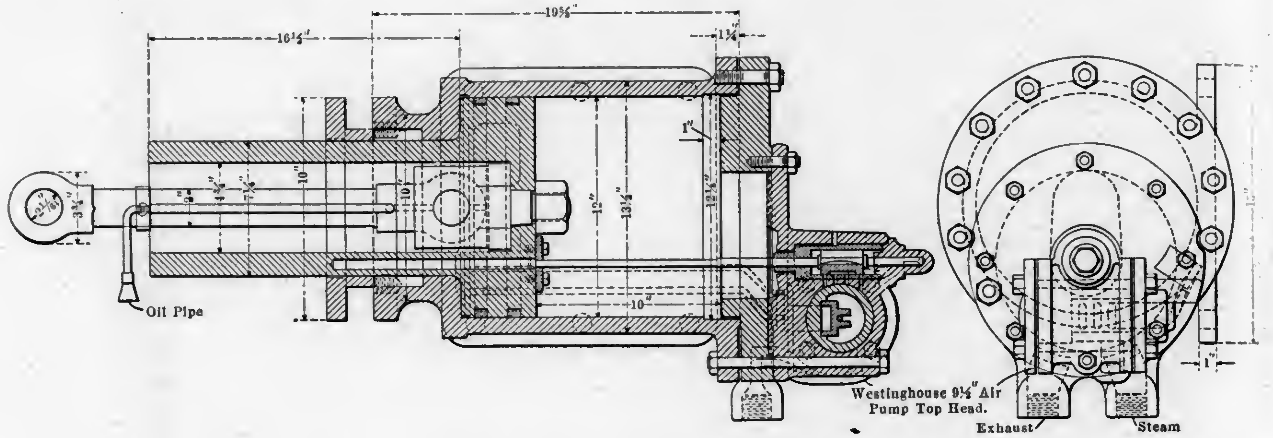
out the stoker and fires are cleaned through dump grates in the front as usual.

It is occasionally necessary to use the hook in order to level off the fire the same as is done with hand firing. Carefully kept records show that the hook is used as often with the stoker as without, when run of mine coal is in use, but when coal having a large percentage of slack is fired it is necessary to hook the fire more frequently than when firing the same fuel by hand. While the hook is being used there is more or less smoke thrown off, but at other times the combustion is practically smokeless.

As an example of the results being obtained in service with the stoker the accompanying table, showing a number of recent trips of locomotives fitted with it, are given.

February there were but nine trips of less than 100 per cent., all of these but one being over 90 per cent. stoker work, the cause of failure being poor coal and a slight uneven distribution, and in one case the crusher clogged and a 70 per cent. trip occurred. Beginning with the 8th of February there were a long series of 98 and 99 per cent. trips on account of the fire being light at the door. About the 1st of April slight trouble developed with the stoker mechanism, giving two or three poor trips.



STOKER ENGINE USING A 9½-IN. AIR PUMP HEAD AND VALVE GEAR.

LOCOMOTIVE No. 7395. Beginning with the 5th of December the stoker on this engine gave practically perfect service up to January 6th. In one case the stoker engine broke down, giving a 60 per cent. trip; in another case a 75 per cent. trip was caused by the stoker engine not being lubricated. On January 9th the stoker broke down, giving a 25 per cent. trip, and on the 13th the stoker engine stuck, giving a 10 per cent. trip. Following this, however, the perfect trips were continuous up to the 19th, when poor coal caused two bad trips, but from that time to the 4th of April the record is perfect.

LOCOMOTIVE No. 8462. From the time the stoker was installed on November 2nd, very successful results were obtained up to the 17th, when one of the auxiliary plungers stalled, putting the stoker out of commission for that trip. After this was repaired the record is very satisfactory up to December 19th, when a 29 per cent. trip occurred for some reason not quoted in detail. The average steam pressure on this trip was but 183 lbs. One hundred per cent. trips then followed up to the 28th, when the crusher opening became choked up and an 8 per cent. trip followed. For the next thirty days more or less trouble was incurred by poor coal, principally because of it being very fine, and a number of trips of 50 per cent. or less are recorded. The only trouble with the stoker mechanism was in connection with the steam cylinder. Following the 13th of February there was one occasion where one of the rams gave trouble, and some trouble with lubricating the steam cylinder. On March 22 a stoker engine piston broke, and on the 31st two rams stuck fast in the troughs.

								Totals and Averages
Locomotive number	8310	9383	7395	8462	8557	8604	8564	
Class	H 6 b	H 6 a	H 6 a	H 6 a	H 6 b	H 6 b	H 6 b	....
Dates, 1910 and 1911	9-15 to 3-26	10-14 to 4-3	12-5 to 4-4	1-2 to 3-3	1-3 to 4-5	1-24 to 4-4	2-28 to 4-5	....
Total number of separate trips	199	202	103	117	76	59	20	773
Total mileage with train	19122	6451	2580	6000	7476	5495	1974	49,098
Average mileage per trip	96	32 3	31.2	94	98	93	98.7	63.5
Average tonnage per trip	1256	2096	2187.9	1386.5	2310.8	1401	1437	1725
Average speed, M. P. H.	24.2	17.	15.4	24.1	22.	23.5	24.3	21.5
No. times fire-hooked, average per 100% trips	11	3.1	2.2	7.2	9.1	6	6	6.8
No. times grates shaken, average per 100% trips	8.1	2	1.7	7.5	7.5	7	4	5 4
No. of trips with 100% stoker work	85	171	98	69	39	39	16	517
No. of trips with stoker work of over 90%	38	22	....	20	21	9	3	113
No. of trips with stoker work from 50% to 90%	61	7	3	20	10	7	... .	108
No. of trips with stoker work less than 50%	15	2	2	8	6	4	1	38
Average per cent. stoker work	80.32	98	97	90.8	85.	94	99.5	92.1

An investigation of the detailed daily reports showing the causes of less than 100 per cent. stoker work from which the above table was made up, reveals the following general information:

LOCOMOTIVE No. 8310. This engine was the first to be equipped with a new No. 14 stoker, and as might be expected for the first few trips considerable difficulty was encountered. The first trip gave but 7 per cent. stoker work on account of coal packing solid in front of the ram. The next trip was 77 per cent. stoker work, and the following day was a 100 per cent. trip. On the fourth trip a pin was lost out of the conveyor, giving a 42 per cent. trip. The next one was a 70 per cent. trip on account of imperfect distribution because of clinkered coal. Following this trouble was encountered on the next two trips by the troughs choking up or the crusher clogging. On the next day there was a 100 per cent. trip, and on the next one poor coal and a clinkered fire gave a 40 per cent. trip. From that time on for practically a month the operation was almost perfect, a little difficulty being encountered occasionally with poor coal, giving a clinkered fire, necessitating some hand firing. Following this, clinkered fire gave more and more trouble and experiments were carried on to overcome it. In fact this difficulty continued for two or three months, during which time there was only an occasional 100 per cent. trip, but many of nearly 100 per cent., the clinkered condition of the fire requiring a little hand firing but the stoker doing practically all the work. About the beginning of February conditions improved and 100 per cent. trips became very frequent. Trouble with the stoker mechanism on this locomotive throughout have been very slight.

LOCOMOTIVE No. 9383. This engine was equipped on the 14th of October and gave very good results right from the start. On the fifth trip hand firing was resorted to on account of the conveyor saddle breaking. The following four or five trips gave some trouble with clinkered coal, which was soon corrected, and from the 8th of November to the 8th of

LOCOMOTIVE No. 8557. The stoker on this engine, which was applied on the 3rd of January, gave comparatively few 100 per cent. trips, principally on account of poor coal, although the mechanism itself was subject to a number of accidents, some of these enumerated being: broken crusher stud, crusher choked, connector bolt loose, stoker engine piston head loose, stoker engine out of order, stoker stalled, large lump caught in crusher, main stoker shaft key lost, and slack coal stalled conveyor. The average percentage of stoker work on this engine for the seventy-six trips recorded is but 85 per cent.

The following two engines, one of which was equipped on the 24th of January and the other on the 28th of February, have given very excellent results up to date. The difficulties that have occurred have been principally due to clinkering and fine coal.

The record of these seven engines, covering 773 separate trips, and mileage with train of about 50,000 miles, gives an average per cent. of stoker work of 92.1 and a percentage of perfect trips of 67 per cent.

Locomotive Terminal at East Clinton, Ill.

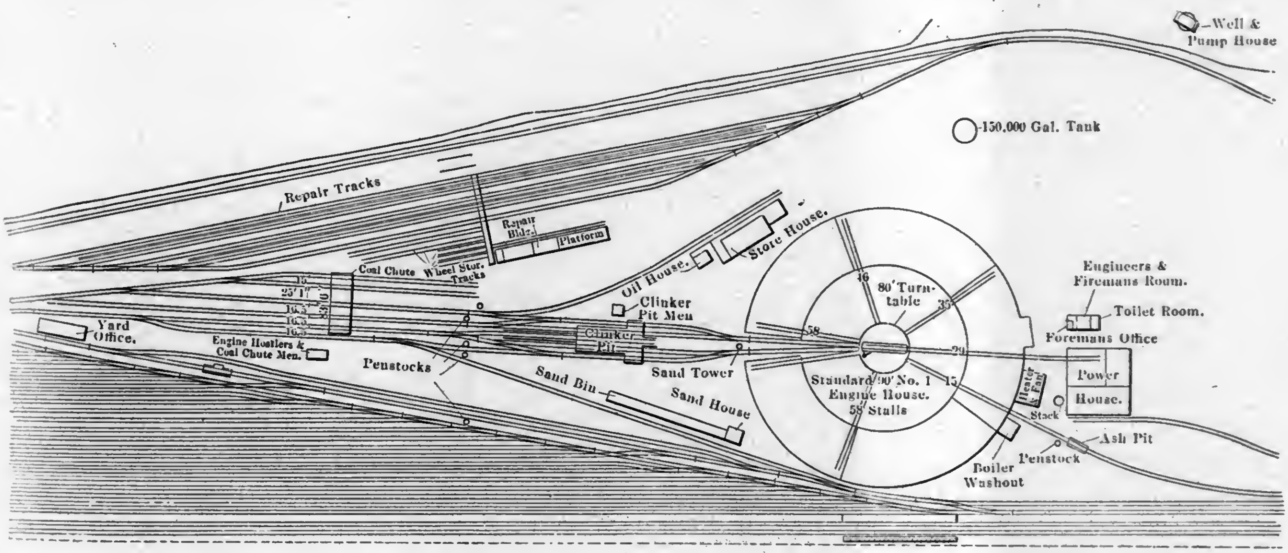
CHICAGO & NORTHWESTERN RAILWAY.

IN CONNECTION WITH THE LARGE YARDS ON THE EASTERN SIDE OF THE MISSISSIPPI RIVER OPPOSITE TO CLINTON, IA., WHICH THE CHICAGO & NORTHWESTERN RAILWAY HAS RECENTLY CONSTRUCTED, A LOCOMOTIVE TERMINAL FOR FREIGHT ENGINES, CONSISTING OF A FIFTY-EIGHT STALL ROUNDHOUSE AND AUXILIARIES TO SUIT, HAS BEEN BUILT.

In 1900 the Chicago & Northwestern Railway erected at Clinton, Ia., a new 50 stall roundhouse, replacing an older and similar structure at the same point,* the layout being so planned as to provide for another roundhouse of the same size when needed. Since that time, of course, traffic has greatly increased and necessarily the number of cars handled has increased more rapidly than the number of locomotives, and when it was found imperative to greatly enlarge the existing yards the decision was made to build entirely new yards across the river from the present terminal and transfer all freight traffic to that point, therefore the original plan at Clinton has not been carried out and an entirely new locomotive terminal has been constructed in connection with the new yards and at this point all freight engines will be taken care of, leaving the present 50 stall house for passenger service only.

For the purpose of facilitating the movement of locomotives as much as possible the new terminal has been located at a convenient point near the center of the yards, so that locomotives going to or coming from the roundhouse will require a minimum amount of switching and a minimum distance to travel. It is planned to have all incoming and outgoing engines handled from the western side of the roundhouse, although a single exit and entrance track has been provided on the eastern side, being equipped with a small ash pit and water crane. A study of the general layout will show that there are two tracks coming from the yard which branch into four tracks before reaching the coal chute, on any one of which coal can be taken. These four tracks continue over the cinder pit and then combine into two tracks, which are continued to the turntable. The two inner tracks of the four are intended for incoming engines and are served by cinder pits 102 ft. in length. The outer two tracks are intended for outgoing engines and have a small cinder pit, being an extension at the side of the longer one, arranged as is shown in the plan. Crossovers are provided between the first and second and third and fourth tracks, so that incoming engines can be run around those that may be on the pit and brought into the house more quickly. A branch from the southerly track, being taken off between the coal chute and cinder pit, permits a reverse movement eastward for engines going to that end of the yard. The water cranes are located about midway between the coaling station and cinder pit and all sanding is done at the sand tower just before going on to the turntable

Other buildings in connection with the terminal consist of a large structure 100 x 110 ft., which houses the machine shop, the blacksmith shop and powerhouse; it is located just to the east of the roundhouse. Adjoining this is a small brick building containing the engineers' and firemen's rest and wash rooms, foremen's office, etc. On the other side of the roundhouse is the store and oilhouse, in separate buildings, and beyond are tracks for car repairs, with a small shop for wheel and blacksmith work. The whole terminal is well grouped, the total distance from the coaling station to the powerhouse being but about 1,200 feet.



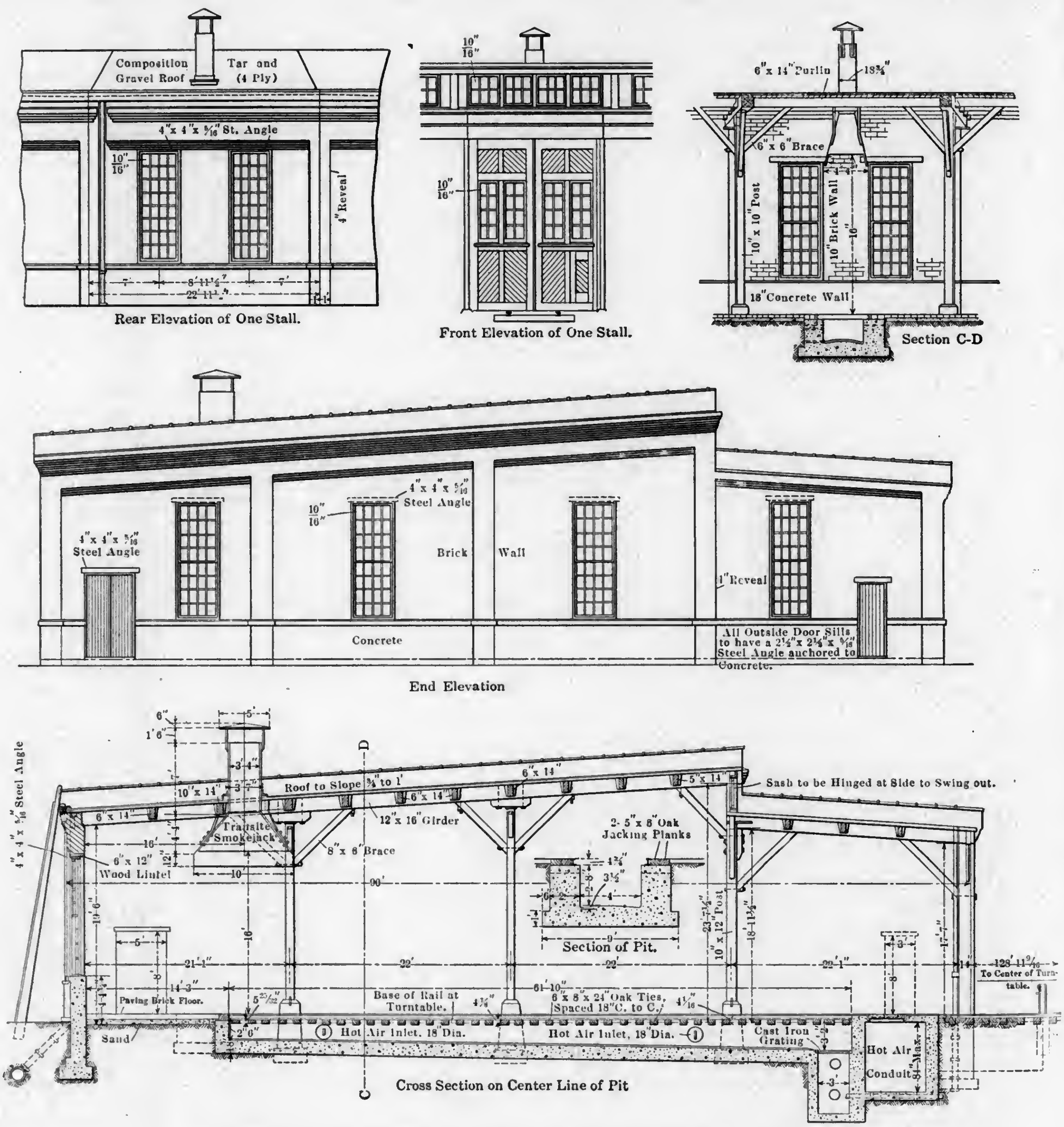
GENERAL LAYOUT OF FREIGHT LOCOMOTIVE TERMINAL AT EAST CLINTON, CHICAGO AND NORTHWESTERN RAILWAY.

ROUNDHOUSE.

The roundhouse measures 90 ft. between walls and the inner circle has a radius of about 129 ft. The 58 stalls in the house, with the two entrance tracks, give an angle between tracks of 6 degs. Since the turntable is 80 ft. in diameter this requires the use of frogs around the turntable circle. The distance between the center of the tracks at the outer wall is 22 ft. 11½ in. and at the inner wall 13 ft. 6 in. The house is divided into five sections by four fire walls, giving three sections with 12 tracks each and two with 11 tracks. Doors are provided in the fire walls at both the outer and inner circle.

Following the standards of the company for roundhouses, the building consists of a concrete foundation carried up to the level of the window sills and a brick outer circle and end walls above the window sills, with a simple design of wooden roof. The distance from the floor to the underside of the roof timbers at the outer wall is about 19 ft and from this point the

* See AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1901, p. 25.



ELEVATIONS AND SECTIONS OF STANDARD 90 FT. ROUNDHOUSE—C. & N. W. RY.

roof slopes upward at an angle of about ¾ of an inch to the foot for a distance of 55 ft., where a series of vertical windows are inserted and a drop of about 5 ft. is made when it slopes downward to the inner circle, giving a distance of about 17 ft. from the bottom of the roof timbers to the rail at the doors. This type of roof and general arrangement has been found to be entirely satisfactory in giving good ventilation and lighting. The smoke jacks are located about 16 ft. from the outer wall and do not provide an opening for ventilation around the outside of the vertical pipe. They are carried up about 6 ft. above the roof level and provided with hoods and dampers, as is shown in the illustration. The roof is covered with a four-ply composition tar and gravel roofing and the gutters are arranged to drain through down spouts on the inside of the house at the inner circle and outside of the walls at the outer circle. The vertical sash in the roof is hinged to swing outward.

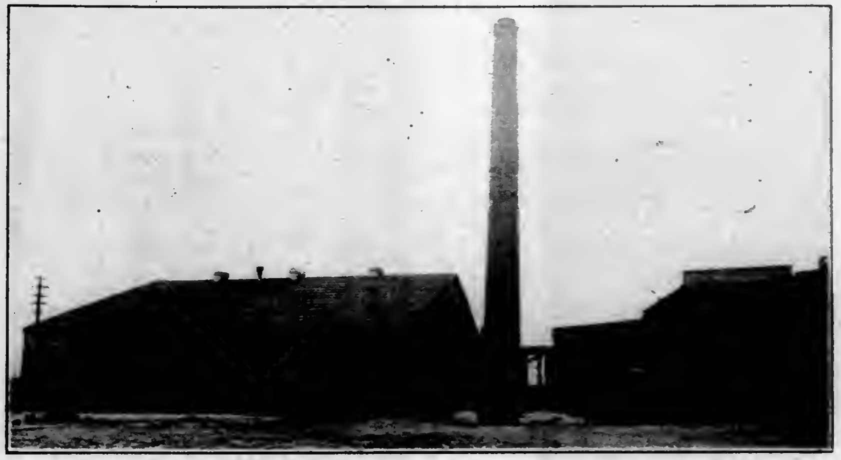
An inspection of the illustrations show that the window area while carried to a good height is not as large as has been customary in other terminals or as would have been easily possible. There are two narrow windows opposite each pit in the outer circle and about one-third of each door is given up to lighting area, this in connection with the four swinging sash in the roof, about 4 ft. in height, constitutes the whole natural lighting area, giving a total of 134 sq. ft. per pit.

Transit board smoke jacks, with an opening at the bottom of 4 ft. 4 in. x 10 ft., narrowing up to a cylindrical section 3 ft. 4 in. in diameter, are installed over each pit. With the ordinary consolidation locomotive when its stack is under the center of the jack the pilot will be about 7½ ft. from the wall. These smoke jacks are arranged with 16 in. wings extending down on the sides, the ends being 16 ft. above the rail. They are supported directly from the roof timbers without any special construction.

One of the illustrations shows cross sections of the pits, which are of concrete 12 in. thick at the bottom and 2 ft. thick at the sides, having a slope, relative to the rail level, of 8 in. in their

length of 61 ft. 10 in. They drain toward the inner circle, there being a deep concrete sump covered with a cast iron grating at the inner end of each pit. The depth at the front is 2 ft. 10¾ in. from the top of the rail. The rail itself, and in fact the whole floor of the roundhouse, has a slope toward the inner circle of about 5 in. in its length, this grade being continued to the turntable pit. The pit rails are carried on sections of oak ties spaced with 18 in. centers embedded in the concrete, which is carried up flush with the top of these ties and capped by two 5 x 8 in. jacking planks on the outside of each rail.

Heating System.—Hot air is used for heating, the same as was installed in the roundhouse built eleven years ago, although in that case the ducts were carried overhead and in the present case they are built of concrete around the inner ends of the pits. In an addition on the outside of the house opposite the entrance track, which measures 40 ft. x 56 ft. 6 in., are installed a duplicate set of Sturtevant fans with coils, each being driven by a 75 h.p. G. E. induction motor. Each fan discharges into a conduit measuring 70 by 84 in., which serve one-half of the house. These conduits grow smaller in size until at the end



GENERAL VIEW AT EAST CLINTON SHOWING CHARACTER OF STRUCTURES.

INTERIOR OF ROUNDHOUSE.

they measure 48 in. x 48 in. in section. Between each alternate pair of pits is carried off a section 30 x 24 in. which branches out and discharges through two 18 in. openings fitted with dampers along one side of each pit. Large dampers are, of course, fitted in the main conduits near the fans, and the coils are arranged in groups so that the necessary amount of heating surface can be employed without waste. Exhaust steam is sufficient for ordinary purposes. The matter of drainage of this hot air conduit has been carefully considered and the whole heating system is reported to be very satisfactory. The top of the conduit forms a concrete walk around the inner circle and doors are cut in the fire wall so that this passage can be freely used.

Lighting.—Artificial lighting is entirely by incandescent lamps which are carried from the roof timbers, the wiring being carried in iron conduits and each group of lights between pits being controlled by a switch on the outer wall.

In the section of the house nearest the machine shop there are two drop pits, one for driving wheels, serving two pits, and the other for truck wheels, serving the next two pits. The driver pit is 7 ft. 10 in. in width and is provided with a telescopic air jack.

The floor is of paving brick laid on the sand, being well crowned to drain into each pit. The end of the pit rails are not provided with stops.

Benches for workmen are located along the outer wall wherever necessary.

Boiler Washing System.—The hot water boiler washing and changing system installed by the National Boiler Washing Co. of Chicago is its standard apparatus. The pipes are carried around the center of the house from the roof timbers, the connections coming down on the center posts between each alternate pit. The pumps and tanks are located in a small addition just outside of the roundhouse wall, adjacent to the power house. This system and arrangement has been fully illustrated and described in these columns.*

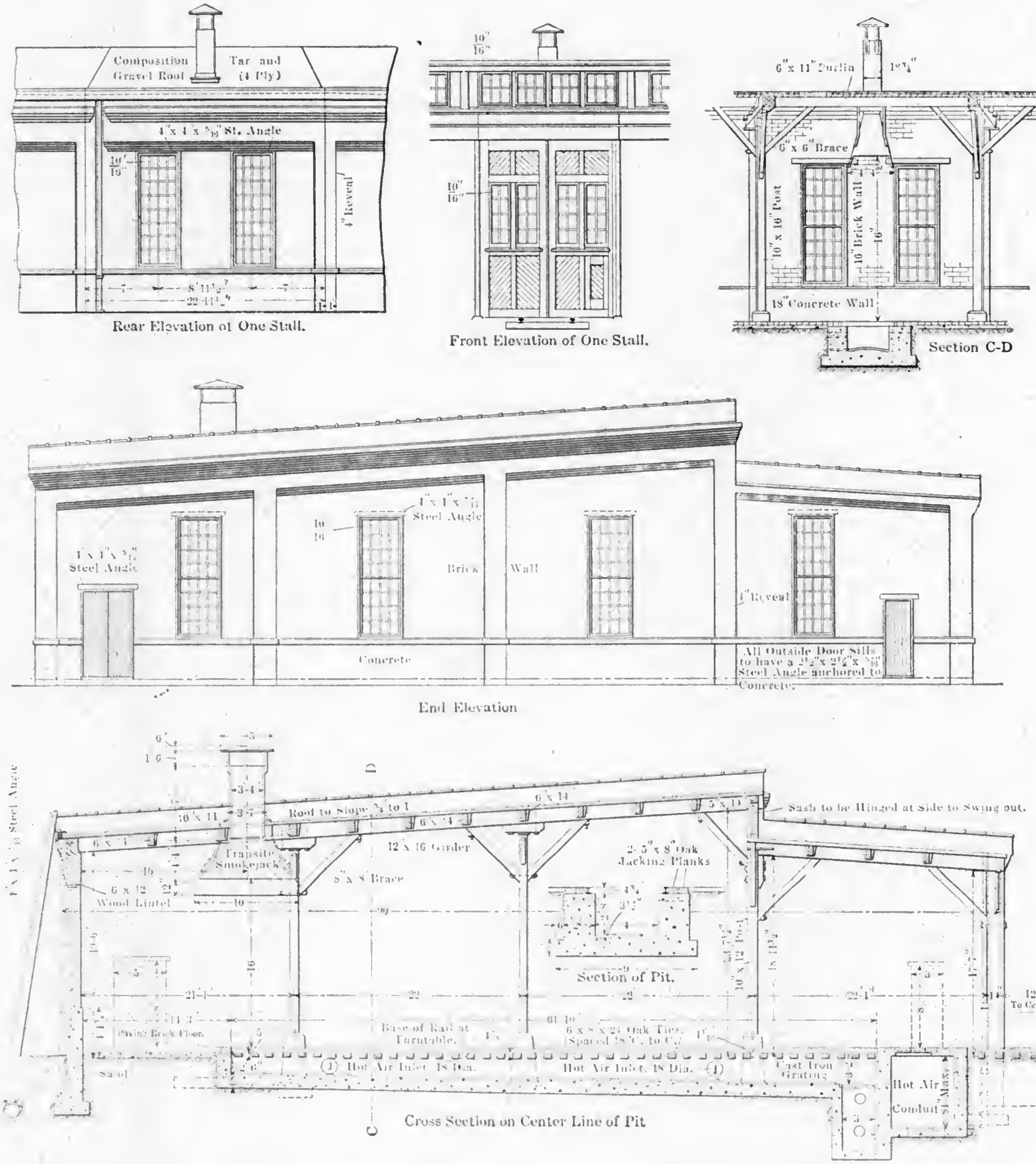
An 80 ft. turntable equipped with an electric tractor has been provided. The turntable was built by the American Bridge Company and the tractor was furnished by George B. Nichols & Bro. The walls of the pit are of concrete, but the bottom is not paved, since the sandy soil in that locality gives good drainage and requires no covering. The electric circuit is carried through an underground conduit to a commutator at the center pin.

Cinder Pit.

The standard cinder pit of the Chicago & Northwestern Railway has been installed at Clinton. In this case it consists of two pits 102 ft. long, with a depressed track between them, and two short pits, 23½ ft. in length, for dumping the ash pans of outgoing locomotives. The pits are constructed of concrete with the outside rail resting on the wall and the inner one being supported on a steel girder resting on cast iron chairs on a concrete foundation located at about 13 ft. centers. The steel girder carrying this rail consists of two 15 in. channels set 6⅜ in. apart, the rail being supported upon a 6 x 4 in. angle riveted to one of the channels, this in turn being reinforced by a 5 x 3½ in. angle secured to the other channel. The bottom of the rail is 2⅜ in. below the top of the channels, the space between being filled with asphalt mixture, and the rail is held in place by malleable iron clips arranged as is shown in the illustration.

* See American Engineer, Dec., 1910, page 469.

VIEW OF SAND TOWER AND ENTERING TRACKS.



ELEVATIONS AND SECTIONS OF STANDARD 90 FT. ROUNDHOUSE—C. & N. W. RY.

roof slopes upward at an angle of about ¾ of an inch to the foot for a distance of 55 ft., where a series of vertical windows are inserted and a drop of about 5 ft. is made when it slopes downward to the inner circle, giving a distance of about 17 ft. from the bottom of the roof timbers to the rail at the doors. This type of roof and general arrangement has been found to be entirely satisfactory in giving good ventilation and lighting. The smoke jacks are located about 16 ft. from the outer wall and do not provide an opening for ventilation around the outside of the vertical pipe. They are carried up about 6 ft. above the roof level and provided with hoods and dampers, as is shown in the illustration. The roof is covered with a four-ply composition tar and gravel roofing and the gutters are arranged to drain through down spouts on the inside of the house at the inner circle and outside of the walls at the outer circle. The vertical sash in the roof is hinged to swing outward.

An inspection of the illustrations show that the window area while carried to a good height is not as large as has been customary in other terminals or as would have been easily sible. There are two narrow windows opposite each pit in outer circle and about one third of each door is given u lighting area, this in connection with the four swinging sas the roof, about 4 ft. in height, constitutes the whole na lighting area, giving a total of 134 sq. ft. per pit.

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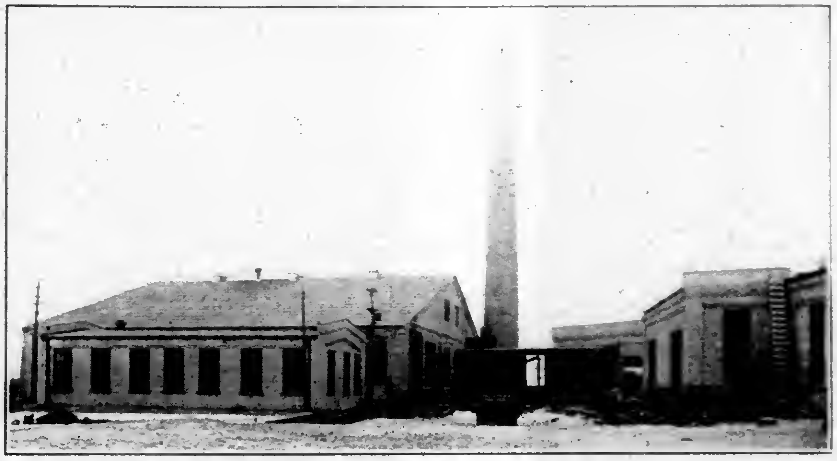

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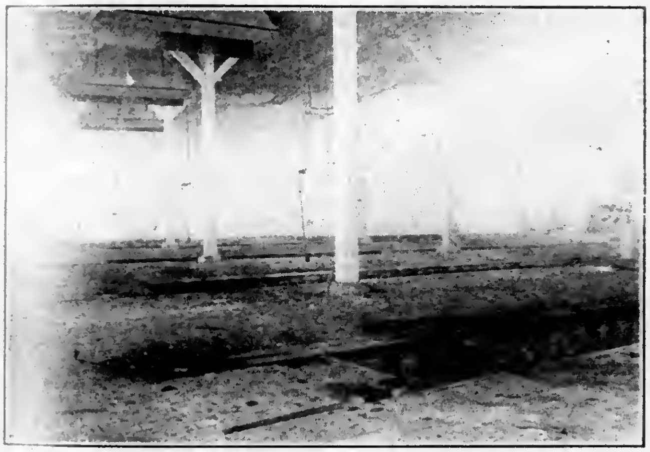

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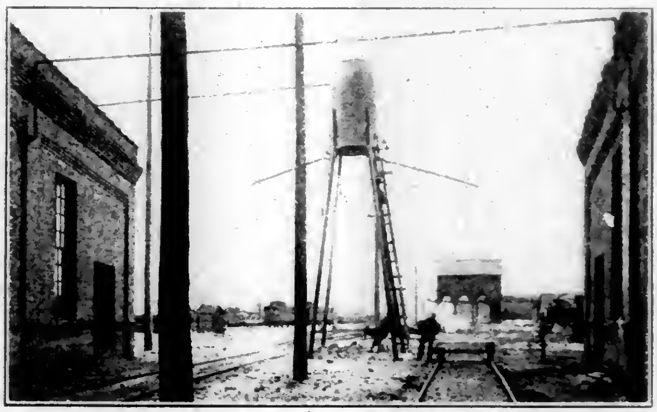

VIEW OF SAND TOWER AND ENTERING TRACKS.

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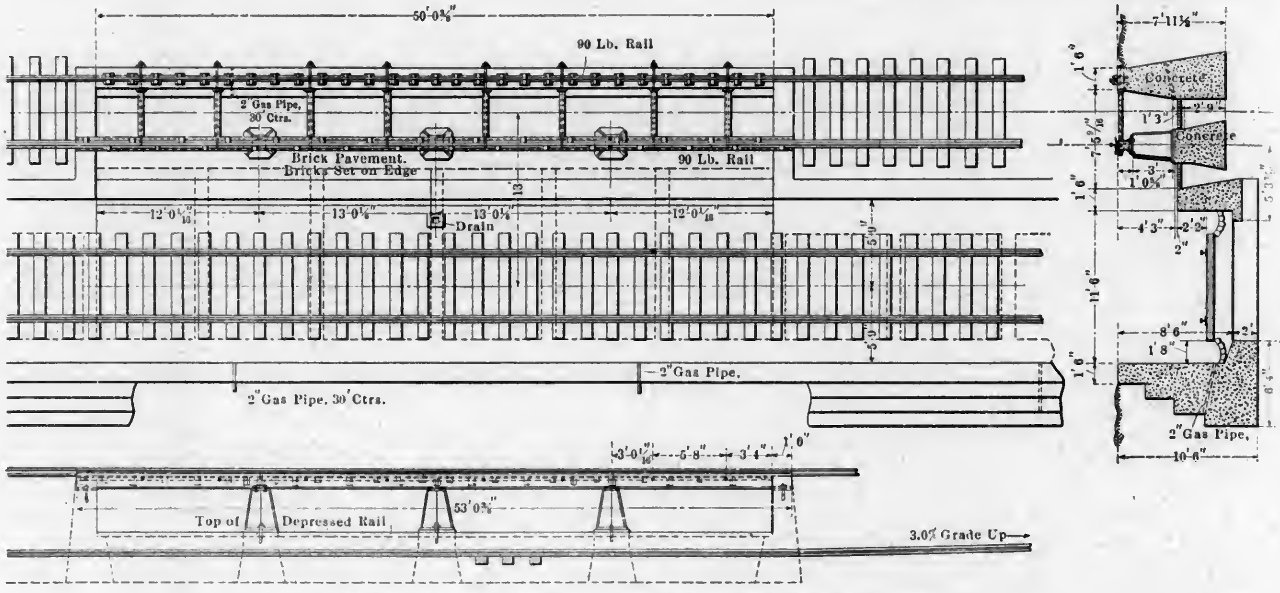
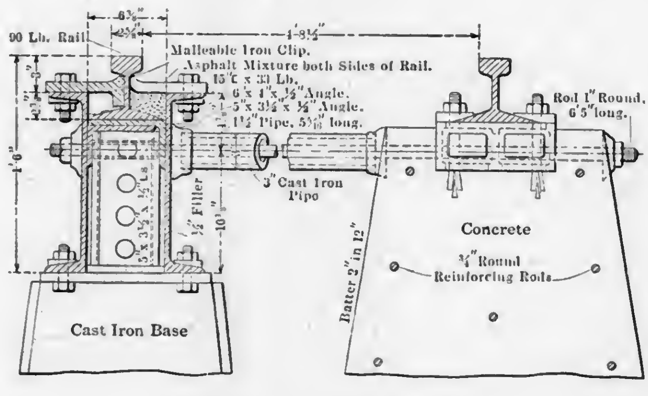


STANDARD ASH PIT OF THE CHICAGO AND NORTHWESTERN RAILWAY.

Shops and Powerhouse.

The building containing the powerhouse and shops is a brick structure with steel roof trusses and tile roof and conforming in its excellent exterior appearance with the roundhouse and other buildings. The small machine shop occupies a space of about 50 x 65 ft. in one corner of this building, which has been provided with a floor of creosoted wooden blocks. The tools are belted from a line shaft which is driven by a 35 h.p. G. E. induction motor located in the engine room adjoining. A track extends into the machine shop from one of the pits in the roundhouse.



DETAIL OF C. & N. W. ASH PIT.

At the present time there has been installed in the machine shop, two lathes, a planer, shaper, double headed boring mill, drill press, punch and shear, bolt cutter, hydraulic press and emery wheel. A motor driven wheel lathe is to be installed in the near future.

A small blacksmith shop has been provided in an unused part of the boiler room.

In the boiler room of the powerhouse there have been located five 150 h.p. fire tube boilers carrying a working pressure of 125 lbs. The draft is furnished by a brick stack 125 ft. in height. The engine room contains two alternating current generators, each driven by a Russell 20 x 20 in. single cylinder engine. The generators have a capacity of 250 k.w. each. A duplex air compressor is also provided in the same quarters.

Coaling Station.

As is mentioned above, the coal chute is arranged to serve four tracks, three passing underneath the storage bins and one at the end. This station is of 800 tons capacity of the double balanced elevator type, built by Fairbanks, Morse & Company. The conveying apparatus is in duplicate and is arranged to both elevate and transport horizontally. The conveyors are driven by a 20 h.p. induction motor.

Water Supply.

The water supply is taken from the Mississipii River, on the banks of which are two three-plunger vertical pumps, each driven by 25 h.p. induction motors, discharging into a large steel tank of 150,000 gallons capacity, which furnishes the pressure and storage for the whole terminal.

SUPERHEATERS ON LONDON & NORTHWESTERN RAILWAY.

On page 101 of the March issue of this journal, the experiments which the London & Northwestern Railway were making with superheaters were mentioned as being one of the most thorough and important tests of this kind that had ever taken place. It was there stated that the superheater being used was very similar to the Schmidt. We have been informed that this superheater was actually of the Schmidt design and the results of these tests have been such as to lead the London & Northwestern Railway to order 100 superheaters from the Schmidt Company for immediate application.

The Next Annual Convention of the International Master Boiler Makers' Association will be held at Omaha, Neb., on May 23, 24, 25 and 26. The Rome hotel has been chosen as official headquarters. H. D. Vought, 95 Liberty street, New York, is secretary.

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JIG FOR SETTING ECCENTRICS

AMERICAN LOCOMOTIVE CO.

The location and subsequent cutting in the axle of eccentric keyways in connection with engines equipped with the Stephenson link motion has always been a very troublesome operation, and one which has uniformly constituted the source of much delay in the erecting shop. Under the plan generally followed the wheels are transferred to that department with the eccentrics merely tightened in approximately their correct position by the set screws, and the keyways are not laid out until the valve setting procedure is finally complete This, of course, implies that the axle must be drilled and chipped in very narrow confines under the locomotive in which to work, and in view of the obstacles in the way which need not be enumerated, fifteen hours is not considered ordinarily as an excessive length of time to devote to the job.

This time-honored method, however, laborious as it may be, has the merit of insuring absolute correctness in the setting of the eccentrics and immunity from "lipped" or offset keys, the latter being a very important consideration now that the eccentrics have become so heavy and the shearing stress on the key has greatly increased. It is for the sake of securing this exactness in location that the plan of keying on the eccentrics as the last detail in valve setting has been so long adhered to, and despite the fact that many ingenious means have been devised to locate them before the wheels go under the engine they have not been received with any particular favor because of the liability to error which all of them embody in varying degrees.

Railroad repair shops in practically every instance follow the old plan, and as main axle renewals are comparatively infrequent in locomotive maintenance, these shops are not greatly embarrassed by delay, notwithstanding the cumbersome nature of the work. In the instance of the locomotive builders, however, the matter assumes a much more serious phase, and it becomes almost imperative that the wheels should leave the machine shop with eccentrics mounted and keyed on the axle, and with their straps applied ready for the blades.

In some instances twenty engines of uniform design may be erected simultaneously and the inconvenience to the erecting department in removing eighty eccentrics, cutting an equal number of keyways and reassembling the parts may be imagined. It may be also well to recall that no matter how extensive such an erecting department may be, there is usually only one valve setting gang available for the work.

Probably the most effective device for properly locating eccentrics in the machine shop is that herein illustrated. It is in daily use at the Cooke Works of the American Locomotive Company, in Paterson, N. J., and the results attained are truly remarkable. On one occasion a record was kept of eccentrics located on fifty engines, and in this total, representing 200 keyways, it was necessary to offset only one key, and that but one-sixteenth of an inch.

AN INGENIOUS DEVICE FOR LOCATING ECCENTRIC KEYWAYS.

Although one of the least known of the American Locomotive Company's various branches, the Cooke Works has in the past numbered some of the most resourceful mechanics on its roster that the country has produced. It was famous a decade ago for the labor-saving devices and methods for doing work, and many of these appliances are still in use, notwithstanding the radical transformation in power which has characterized the intervening period. It is believed that the first set of eccentrics were keyed on in this plant without the preliminary of valve-setting. This was in the instance of an engine with 24 in. stroke, 5 in. maximum valve travel, ¾ in. outside lap, ⅛ lead, and with both rocker arms the same length, which latter was universal practice at that time. These eccentrics were set merely by measurement, the wheels being placed on the forward center for the side being worked on, and the forward motion eccentric advanced from its right angle position with the pin a distance equal to the sum of the lap and lead. The success which extended this departure from the former time-honored method resulted in the development of the elaborate jig for setting eccentrics which is now in use at that plant.

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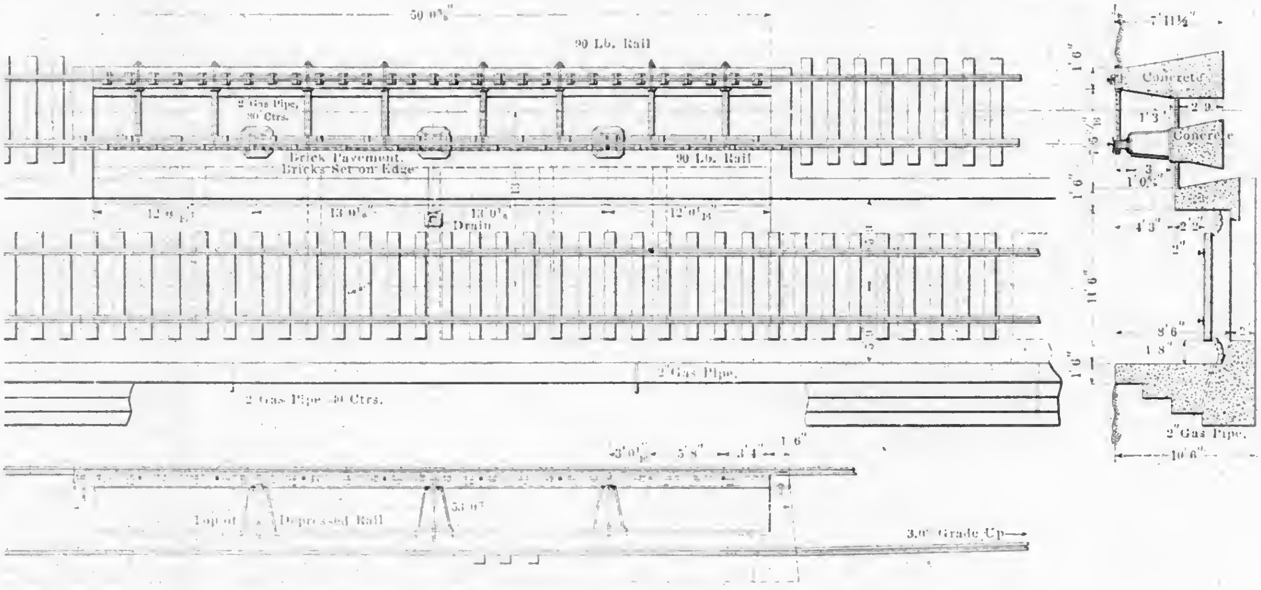

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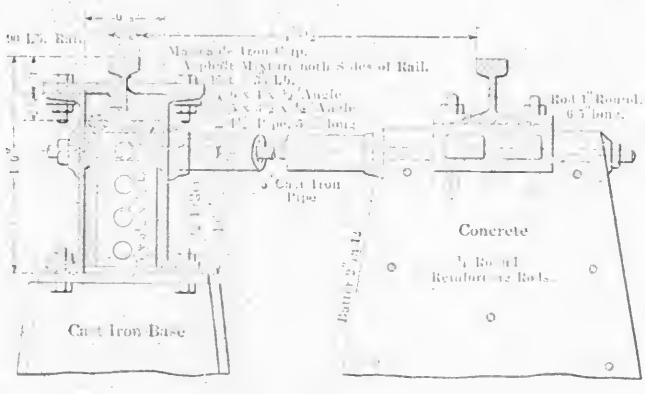

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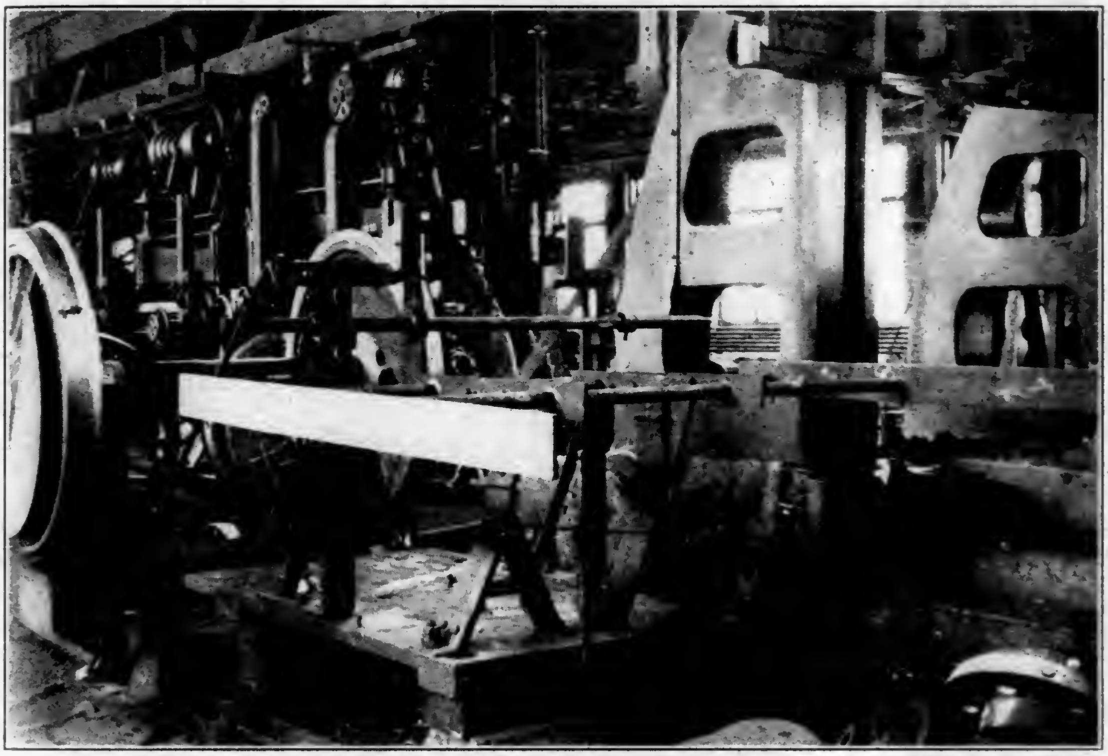

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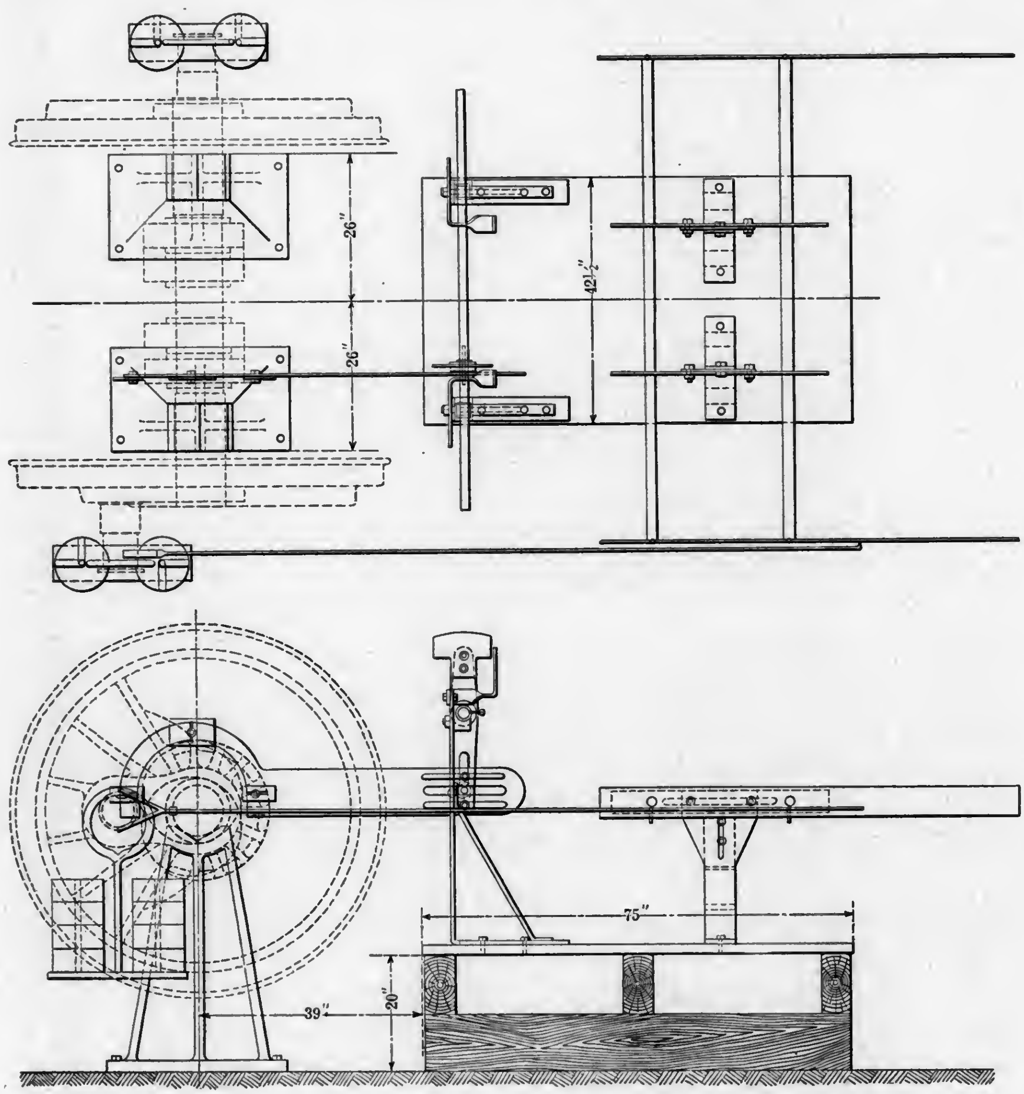
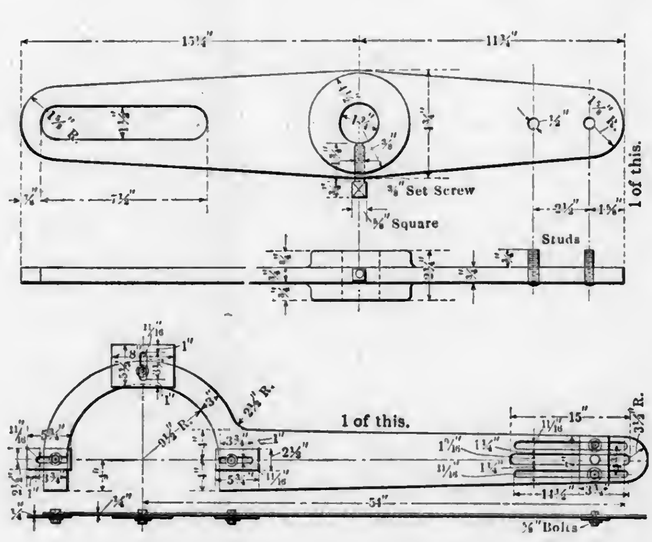
drawing of the rocker arm and the eccentric rod. The wheels are placed by the crane on the supporting blocks and the counterweights properly balanced to permit easy turning. The eccentrics, of course, are temporarily secured in approximately the correct position and the wheel centers are marked on the long slide index which may be chalked for ready reference. The prints of the motion indicate the amount of lap and lead desired, and all can be faithfully reproduced in the jig by means



GENERAL ARRANGEMENT OF ECCENTRIC SETTING DEVICE.

of trams. The general procedure is so similar to actual valve setting on the locomotive that no extended description is necessary.

The contrivance is thoroughly practical, and is of inestimable value in cases where a long run of this particular work is in order. It restricts the erecting shop valve setting to the mere adjustment of the eccentric rods, and the cutting of the keyways is resolved into a very simple matter through their accessibility with the wheels on the floor of the shop. While wheels are in the jig the entire manipulation of the latter can be effected by a single operator.



ADJUSTABLE ROCKER AND ECCENTRIC ROD.

VANDALIA ACCIDENT RECORD.—Records just compiled by the Vandalia Railroad Company show that in 1908, 1909 and 1910 not one passenger out of a total of 9,800,030 carried was killed in a train accident on that railroad. The Vandalia Railroad operates 923 miles of line, though it has in all 1,716 miles of track. Its passenger trains have traveled a total of 7,665,479 miles in the past three years, carrying 330,348,935 passengers one mile, and not a single passenger was killed. Counting all passengers injured in the three years, however trivial, there were only 67.

Maximum Power Locomotives 2-10-10-2 Type

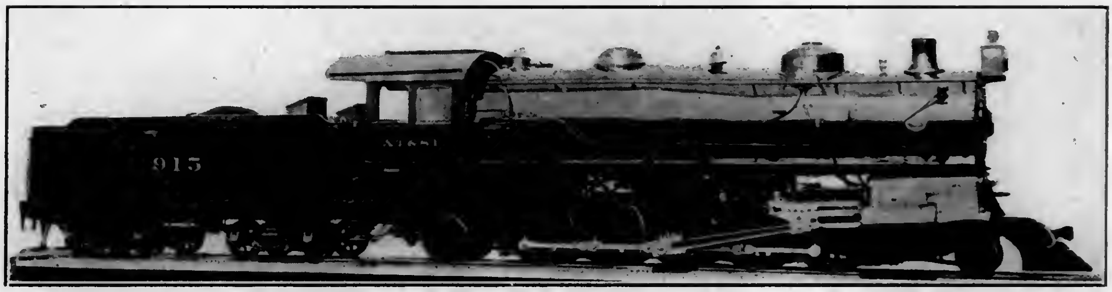
M. H. Haig.*

A practical assignment of power provides not only for the selection of locomotives capable of handling maximum trains over the divisions to which they are assigned, but also includes the grouping of locomotives of a single class in order that the largest number of engines may be served by the smallest number of repair parts carried in stock.

A desired increase in the tonnage hauled in single train units introduces the question of reducing existing grades or of providing locomotives of greater capacity since increasing the power by double heading is undesirable for many reasons. Not only is the investment in locomotives unduly increased where double heading is resorted to, but the cost of operation and the cost of maintenance is also increased. The greater cost of such maintenance and operation, as well as the costs of grade reductions, relocation of right of way via lower grade routes, etc., are being converted by the addition of front units to locomotives of the 2-10-10-2 type which have a total weight without tender of 616,000 lbs.

The original locomotives were built in 1902 by the Baldwin Locomotive Works and the front sections have just been completed by the same builders according to the railway company's specifications. The work of conversion is being done in the company's shops at Topeka.

The original locomotives are designated in the Railway Company's classification as the 900 and 1600 classes. The locomotives of these classes are tandem compounds having cylinders 19 in. and 32 in. by 32 in., and operate under a steam pressure of 225 lbs. The drivers are 57 inches in diameter and the tractive effort is 62,800 lbs. Those operating west of Winslow, Arizona, are in oil burning service, while those assigned



TYPE OF LOCOMOTIVE CONVERTED TO MALLETS. THESE ARE THE MOST POWERFUL LOCOMOTIVES EVER BUILT WITH A SINGLE SET OF DRIVERS.

point to the use of the Mallet locomotive as a means of hauling large tonnage without corresponding increase in cost of operation.

It has been demonstrated that locomotives now in service can be converted to the Mallet type at comparatively low expense. This can be done by the addition of front sections to existing locomotives, establishing maximum tractive units and disposing of the old power without the loss incident to scrapping locomotives which are still in good condition, though too light for the service required of them. The conversion of the old engines has the further advantage of providing greater power units which will still be served by the repair parts already carried in stock and the expense of building new patterns and introducing additional castings of new design, is eliminated.

During recent years a few railways have converted some of their locomotives to the Mallet type by the addition of a front unit or section to each locomotive converted. This additional section has included a forward tubular boiler section or feed water heater, a pair of cylinders, a set of connected driving wheels, etc. The locomotives converted have usually been of the consolidation type, though others, for instance the Prairie type, have been included. The records of the locomotives converted indicate successful operation and other roads are investigating the practice.

The most novel undertaking of this nature, however, has recently been performed by the Atchison, Topeka and Santa Fe Railway. In 1902 the Santa Fe Railway introduced a 2-10-2 type of locomotive† weighing 287,240 lbs., having a tractive effort of 62,800 lbs. and known as the Santa Fe type. This type was and still is the largest and most powerful locomotive operating on a single set of driving wheels. Now ten of these to territories east of this point are equipped to burn coal.

The Santa Fe (2-10-2) type locomotive has proved very satisfactory in heavy freight service, especially in mountain districts. No difficulty has been experienced with the long wheel base and with trucks at each end, the locomotive takes curves well, both going forward and backing up. After converting ten of these locomotives to the Mallet type, there will be 151 of the Santa Fe type still in service.

For conversion, ten locomotives were selected which required new fireboxes and general repairs. These were forwarded to the shops at Topeka, where they have been thoroughly overhauled and the necessary changes made for the application of the front sections. While making repairs, the original low pressure cylinders were bushed from 32 inches to 28 inches in diameter to constitute the high pressure cylinders of the Mallet locomotive. In renewing fireboxes the old box of each locomotive was replaced by a firebox of the Jacobs-Shupert type.* In applying new boxes the length of flues remained the same, but the firebox heating surface was increased from 209 square feet to 294.5 square feet, an increase of 40 per cent.

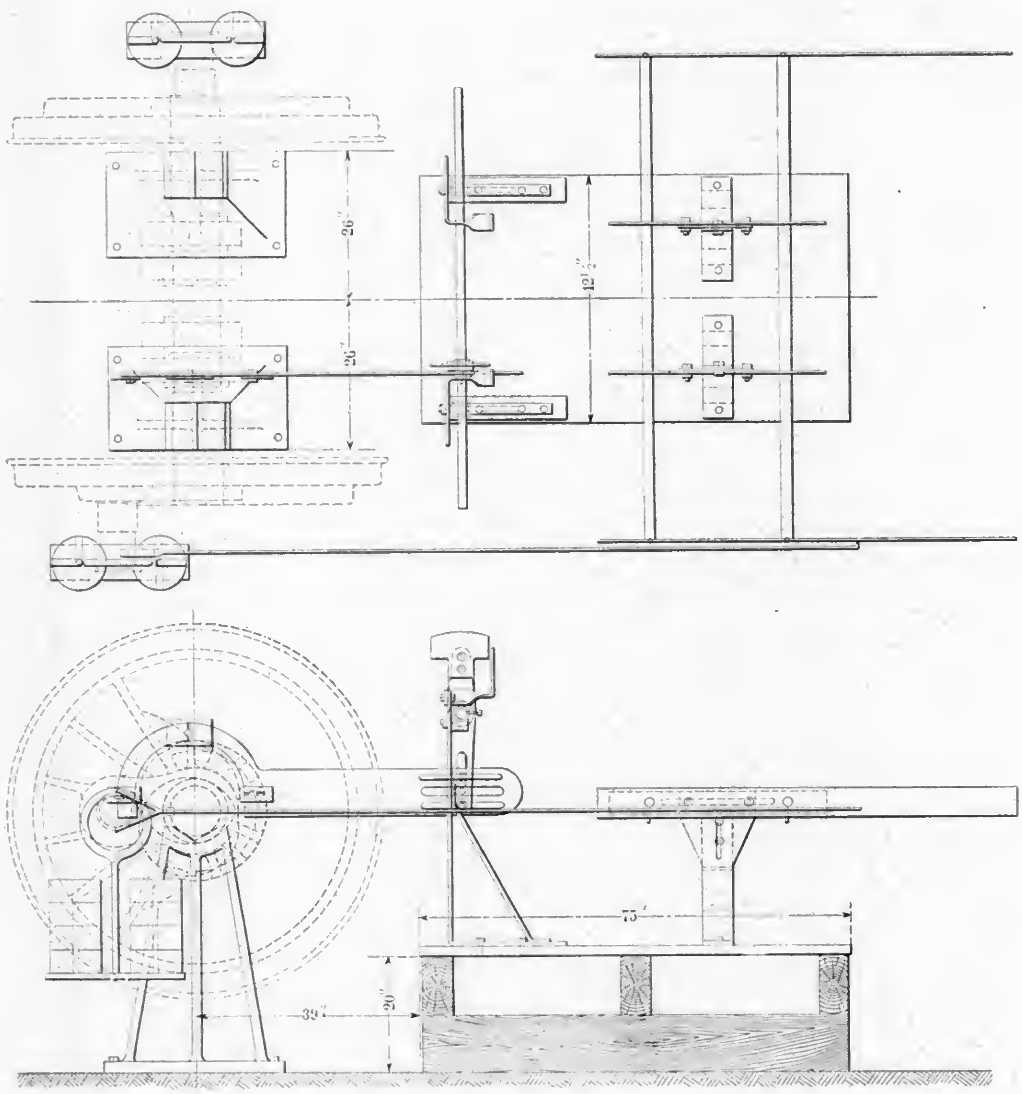
The front section is mounted on a two-wheel leading truck and ten driving wheels. The truck is of the same design as that under the original locomotive and the driving wheel centers are arranged at the same distance as on the original locomotive. The front boiler section includes a feed water heater 106⅞ in. long, located next to the smoke arch, and a superheater 95 7/16 inches long. Between the feed water heater and the superheater is a working space 32 inches long. Access to this working space is provided by a manhole in the shell. The shell of the boiler constitutes the shell of the feed water heater. The heater consists of a set of horizontal flues supported by two flue sheets which are riveted to the boiler shell. Water from the branch pipes passes around these flues, being heated to a

*Mechanical Engineer, A., T. & S. Ry. System.

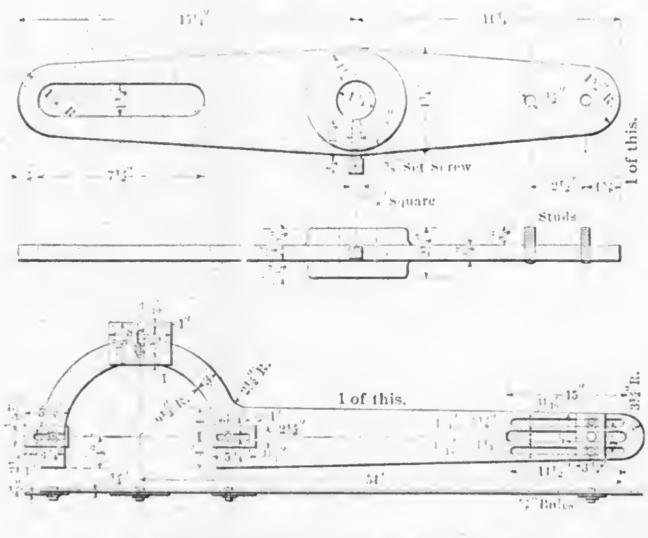
† See American Engineer, Oct., 1903, page 372, and Nov., 1903, page 399.

* See American Engineer, Mar., 1909, page 106.

drawing of the rocker arm and the eccentric rod. The wheels are placed by the crane on the supporting blocks and the counterweights properly balanced to permit easy turning. The eccentrics, of course, are temporarily secured in approximately the correct position and the wheel centers are marked on the long slide index which may be chalked for ready reference. The prints of the motion indicate the amount of lap and lead desired, and all can be faithfully reproduced in the jig by me-



GENERAL ARRANGEMENT OF ECCENTRIC SETTING DEVICE.



ADJUSTABLE ROCKER AND ECCENTRIC ROD.

of trams. The general procedure is so similar to actual valve setting on the locomotive that no extended description is necessary.

The contrivance is thoroughly practical, and is of inestimable value in cases where a long run of this particular work is in order. It restricts the erecting shop valve setting to the mere adjustment of the eccentric rods, and the cutting of the keyways is resolved into a very simple matter through their accessibility with the wheels on the floor of the shop. While wheels are in the jig the entire manipulation of the latter can be effected by a single operator.

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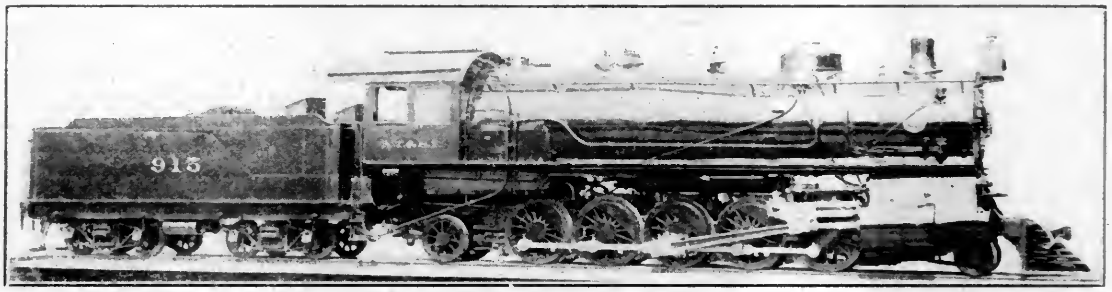

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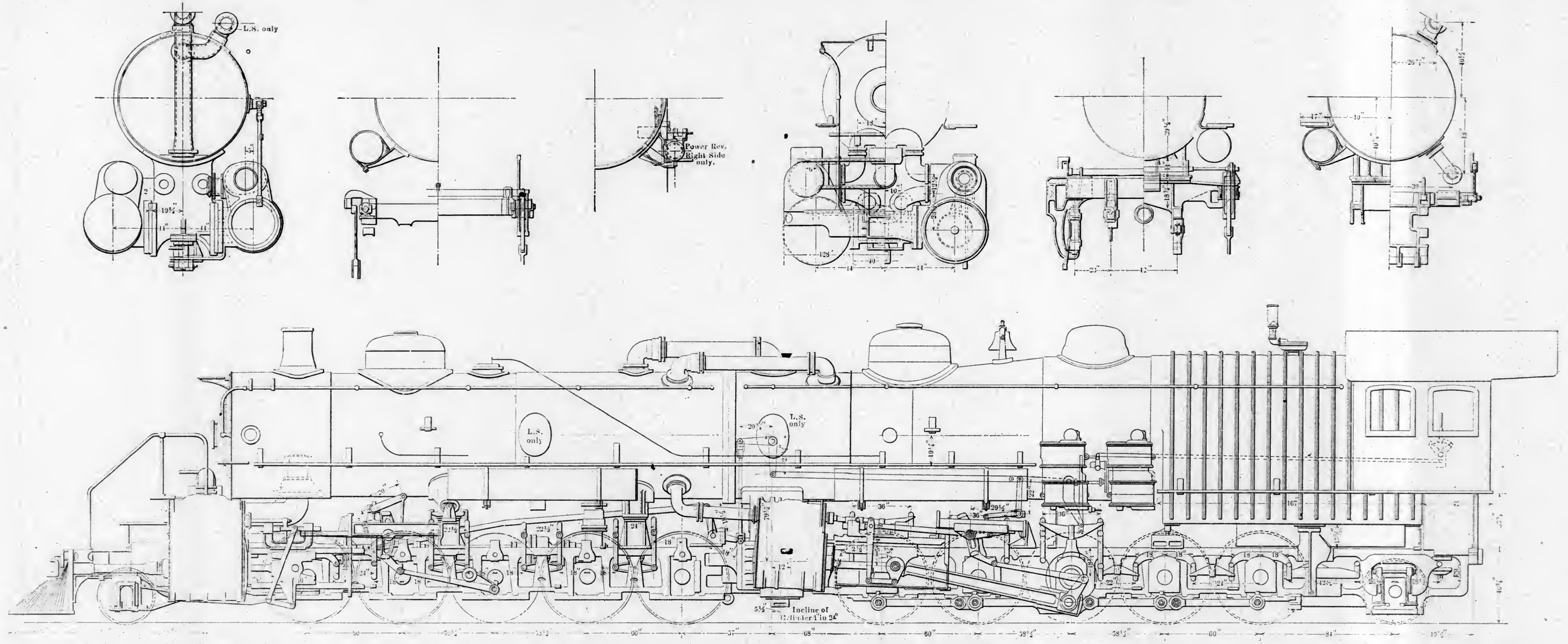
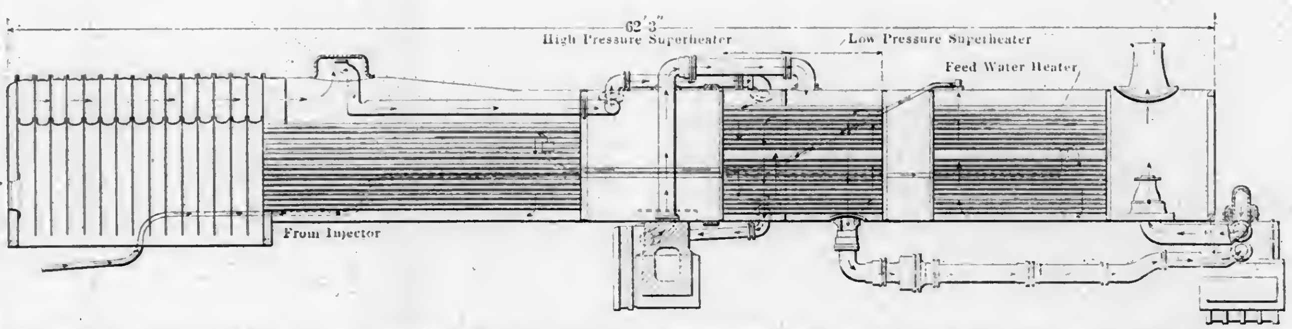
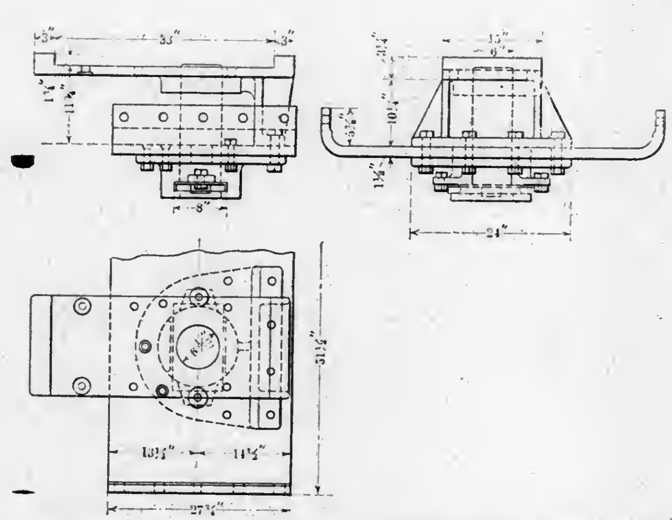


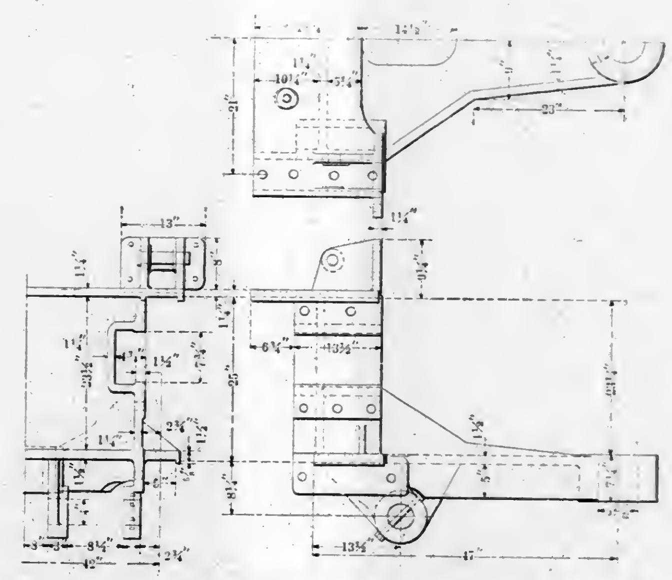
GENERAL ELEVATION AND SECTIONS OF THE LARGEST AND MOST POWERFUL LOCOMOTIVES IN THE WORLD. THE TOTAL WEIGHT OF ENGINE IS 616,000 LBS., AND WITH TENDER IT IS 850,000 LBS. THEY ARE BEING CONVERTED FROM SANTA FE (2-10-2) TYPE LOCOMOTIVES AT THE TOPEKA SHOPS.



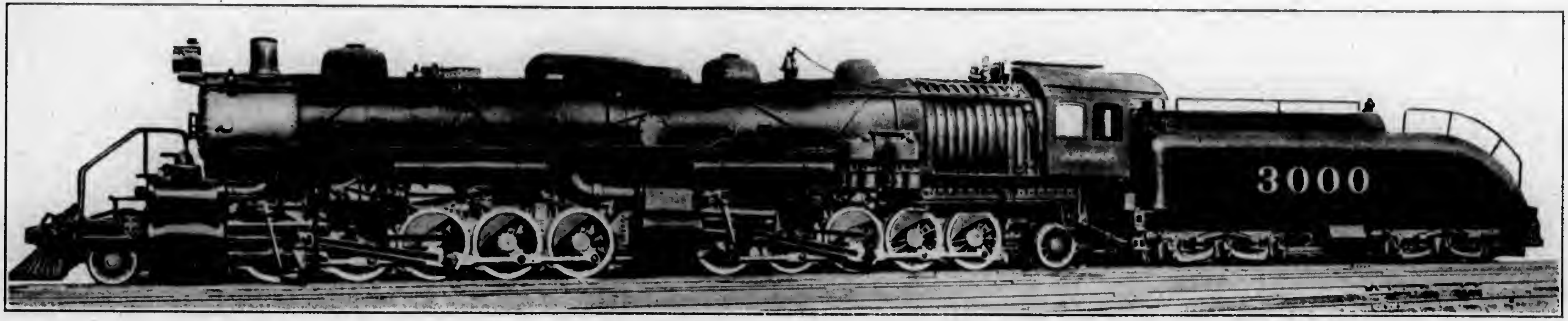
SECTION OF BOILER SHOWING JACOBS-SCHUPERT FIREBOX, BUCK-JACOBS SUPERHEATER AND REHEATER AND THE VERY LARGE FEED WATER HEATER.



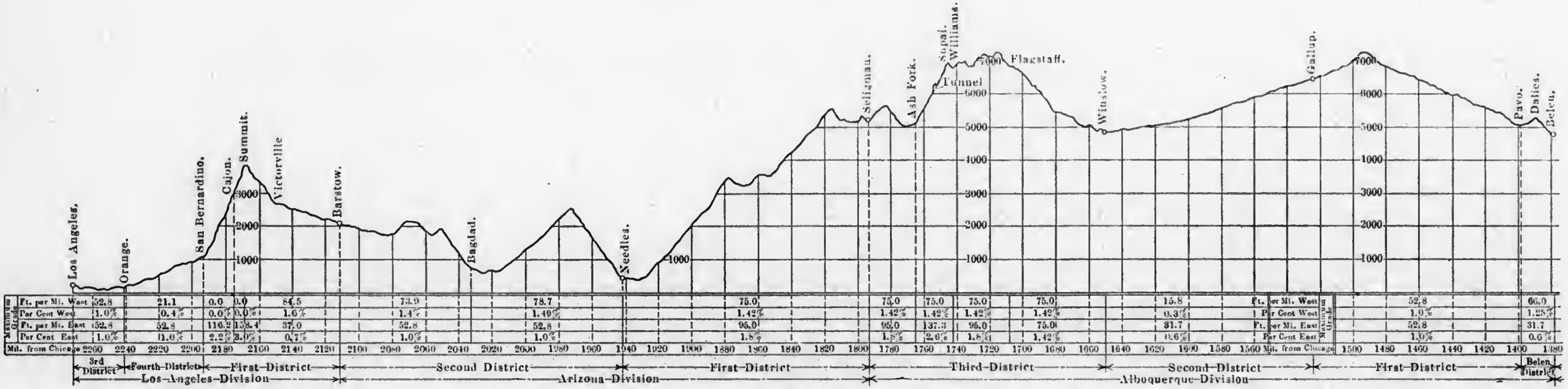
ARTICULATED JOINT CONNECTION AT THE HIGH PRESSURE CYLINDERS.



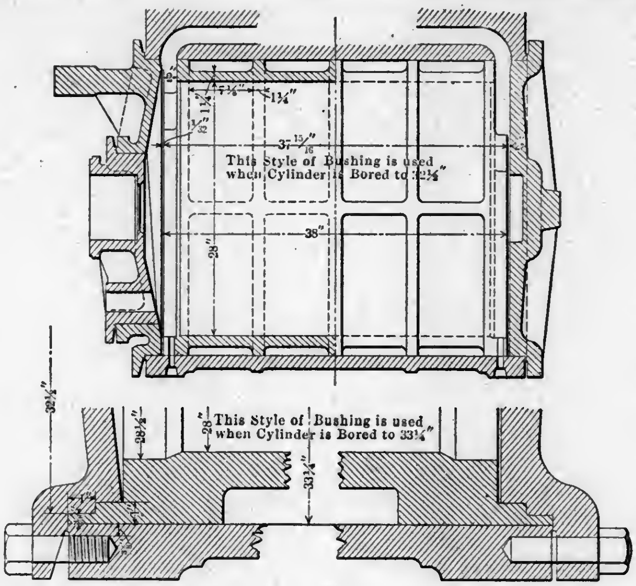
CASTING ON THE FRONT FRAMES FORMING THE CONNECTION AT THE ARTICULATED JOINT.



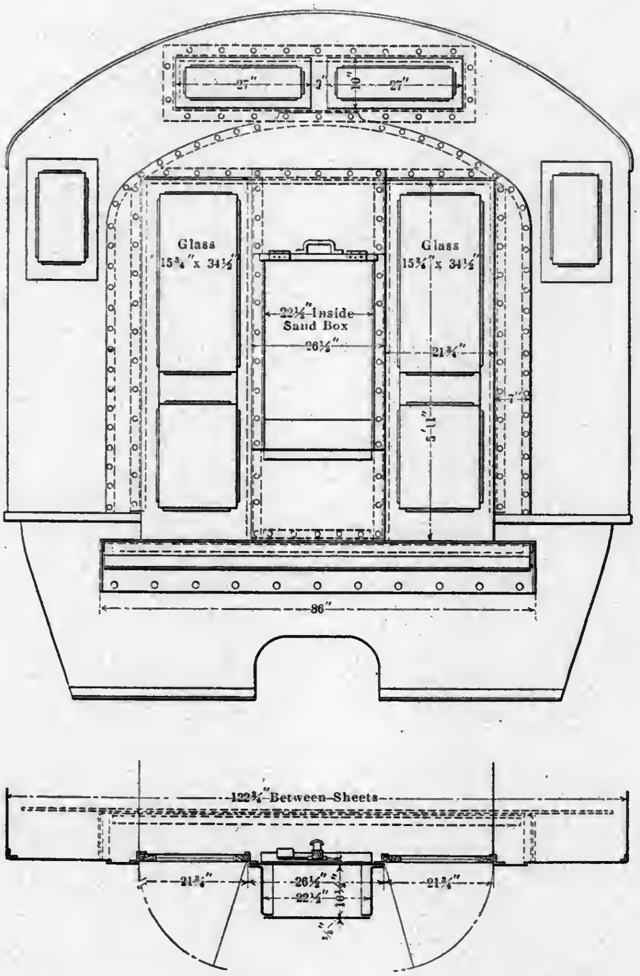
GENERAL VIEW OF THE LARGEST LOCOMOTIVE EVER BUILT.



PROFILE OF SECTION OF THE SANTA FE OVER WHICH THE NEW 2-10-10-2 TYPE LOCOMOTIVES WILL BE OPERATED.



METHOD FOLLOWED IN BUSHING THE LOW PRESSURE CYLINDERS OF THE TANDEM COMPOUND TO FORM THE HIGH PRESSURE CYLINDERS OF THE MALLET.



REAR OF CAB SHOWING METHOD OF ENCLOSING FOR PROTECTION IN RUNNING BACKWARDS.

temperature of about 245 degrees before entering the feed pipe leading to the boiler.

The superheater is of the Buck-Jacobs type.* It consists of a single drum in which the shell is integral with the shell of the boiler. The heads are riveted to this shell and support a set of horizontal flues through which the gases pass on their way from the firebox to the smokestack. An intermediate head divides the superheater into two sections, one in which saturated steam is superheated before entering the high pressure cylinders and a second, and larger, section in which exhaust steam from the high pressure cylinders is reheated before passing to the low pressure cylinders.

The boiler portion of the front section is attached to the former smoke arch of the original locomotive by a separable ring. One section of this ring is riveted to the old smoke arch and the other section is riveted to the new shell just back of the superheater. The joint in the ring is "V"-shaped and the two sections are secured together by horizontal bolts.

In preparing for the articulated joint between the two sections, the front frame rails of the original locomotive were cut off 23½ inches in front of the cylinders. The stub ends of these rails fit loosely between the rear ends of the frame rails of the forward section, according to the usual practice of the Baldwin Locomotive Works in connecting the sections of Mallet locomotives.

The hinge pocket for the articulated joint is provided for by a simple, rigid structure beneath the cylinders. A wrought iron brace 27¾ inches wide is bolted to the frames and spans the space beneath the cylinders. The brace is flanged at each end, the flange engaging the outside of each frame, so that side motion strains on the brace are taken up by the flanges. The brace is secured in position by horizontal bolts passing through the flanges and the bottom frame rails. Beneath the brace at its center a casting is bolted to provide a bearing for the lower end of the pin and this casting carries a plate on which the lower end of the pin rests, to hold it in position. The bearing for the upper end of the pin is provided by a casting bolted to the saddle casting on the seat to which the truck equalizer fulcrum was formerly secured. This casting includes a vertical tail which acts as a buffer for the rear end of the hinge casting carried by the forward section. The pin support under the high pressure cylinders is shown in one of the illustrations.

On the front section the hinge casting, or radius bar crosstie, is bolted to the frames in the usual manner. This casting is so designed as to brace the rear ends of the frames securely and to extend rearward to engage the pin carried by the structure beneath the high pressure cylinders. The details of design of this casting are also shown in the illustrations. The center of the pin is 5½ inches back of the transverse center line of the high pressure cylinders. It is 57½ inches back of the center of the rear drivers of the front section and 57½ inches forward of the center of the front drivers of the rear locomotive section, being located equidistant between the two sets of driving wheels.

In general, the design of the entire locomotive is a combination of the Santa Fe type locomotive and the Prairie Mallet type already in service on the Santa Fe System. The novelty of the design and construction is principally in the size of the locomotive produced and in the conversion of the largest type of locomotive on a single set of drivers to the largest locomotive of the Mallet type. The principal features are similar in details to designs developed by the Santa Fe System in some of its recent locomotives as well as similar to details common to the designs of Mallet locomotives constructed by the Baldwin Locomotive Works.

While the arrangement of steam piping is novel, it is in accord with practice followed by the Santa Fe in its latest purchase of locomotives, including Atlantic, Pacific and Mallet types. The arrangement is peculiar to the design used in connection with the Buck-Jacobs superheater. Steam is led from the dome of the rear section to the front flue sheet by the

*See AMERICAN ENGINEER, Dec., 1909, page 480.

original dry pipe. Here the old tee head is replaced by an elbow casting connecting the dry pipe with a steam pipe extension located outside of the boiler. This extension leads to the high pressure section of the superheater, entering the superheater shell to the left of the center line of the boiler. From points near the bottom of the high pressure section of the superheater, steam is led to each high pressure valve chamber by an individual pipe. Exhaust steam from the high pressure cylinders passes through the original exhaust connections of the old saddle. To the original exhaust pipe seat a long vertical exhaust pipe is connected. This pipe extends to the upper shell of the former smoke arch where it joints an elbow connected with a horizontal outside pipe. This pipe, in turn, leads to an elbow connecting with the low pressure section of the superheater. From the low pressure section of the superheater steam is led to the low pressure cylinders by the usual steam pipe beneath the boiler. By the arrangement of steam pipes described, the joints are on the outside where they are readily accessible, facilitating both inspection and repairs. The joints are removed from the intense heat which tends to cause leaks, and in the event of a leak the steaming qualities of the locomotive are not affected.

Both the high and low pressure cylinders are provided with piston valves. The high pressure valve is 13 inches in diameter and the low pressure valve is 15 inches in diameter. The valves on the original locomotives were actuated by the Stevenson valve gear. On the Mallet locomotive the valves of both the high and low pressure engines are actuated by the Walschaert valve gear. The valve motion is controlled by the Ragonnet reversing gear, a device designed by the Baldwin Locomotive Works, and already thoroughly described.

The ten locomotives being converted are to be placed in service west of Winslow, Arizona, and are equipped for burning oil as fuel. The greater evaporative capacity of the firebox applied, together with the application of superheater and feed water heater, provide for the greater power at the cylinders required by the larger locomotive.

The boiler of each original locomotive was fed by two No. 11 lifting injectors, each capable of delivering 3,800 gallons of water per hour. Each Mallet locomotive is equipped with two No. 12 non-lifting injectors, each capable of delivering 4,200 gallons of water per hour.

Compressed air is provided by two 8½ inch Westinghouse cross compound air pumps. The main reservoir includes three drums having a combined capacity of 100,000 cubic inches. One drum is carried on the right side of the rear boiler section and one drum on each side of the front boiler section.

The cab was designed to provide for the comfort of the engine crew when backing up, as well as when going ahead. Because of the unusual length of boiler it was considered best to provide for running the engine backward in case the long boiler should interfere with the vision of the engineer when running forward. In order that the track can be readily seen from the cab, when looking over the tender, the rear end of the tank is tapered in a manner somewhat similar to the incline at the back of switch engine tanks. A clear view past the tender is still further facilitated by rounding the corners of the tank.

The cab is of steel, lined on the inside with wood, in accordance with the usual design on the Santa Fe System. The back of the cab is entirely enclosed by a rear wall of sheet steel and access has been provided by two doors through this wall. Each door provides an opening 21¾ inches wide and the doors are 26½ inches apart. The upper portion of each door contains a pane of glass 15¾ in. x 34½ in. The doors swing open toward the center of the tank and away from the boiler head. In the extreme upper section of the rear cab wall are two ventilators opening 10 x 27 inches. These are closed by swinging sashes.

On the outside of the rear wall, between the doors, a sand box is mounted. This box is made of ⅛ inch sheet steel. It is 22½ inches long, 10½ inches wide by 27 inches deep. A swinging lid permits access to the sand box for filling. A sand valve is connected to the bottom of the box and protrudes into the cab. This valve provides a convenient arrangement for filling the funnel when necessary to sand the boiler flues. The inclined bottom of the sand box directs the sand toward the valve.

There is ample room between the sand box and the oil tank for a man to pass in moving from one side of the tender deck to the other.

The tenders were designed and constructed especially for the Mallet locomotives, the old tenders formerly applied to the original locomotives being assigned to locomotives in other classes. As explained, the contour of the tank is arranged to facilitate a view of the track from the cab when the engine is running backward. A short pilot is attached to the back end of the tender.

Tne water tank has a capacity of 12,000 gallons and the oil tank a capacity of 4,000 gallons. These are mounted on a built-up underframe of steel carried on two six-wheel trucks. The tender wheel base is 32 feet 6 inches and the trucks are spaced 22 feet between centers. The trucks and underframing are similar in general design to those under the tanks applied to the two passenger and two freight Mallet locomotives delivered to the Santa Fe during the latter part of 1909.*

In addition to the ten locomotives of the Santa Fe type being converted to the Mallet principle, four consolidation locomotives have also just been converted to that type. The general outline followed in converting the 2-10-2 type was observed in converting the 2-8-0 locomotives. The arrangement of feed water heater, superheater, steam connections, etc., is similar, the dimensions of course being modified according to the requirements of the smaller locomotive. The front section is mounted on a two-wheel front truck and four pair of driving wheels, the wheel base arrangement being the same as that of the locomotive converted.

The general dimensions, weights and ratios of the locomotives before and after conversion are given below:

	Original Locomotive	After Conversion
Classes	900 and 1600	3,000
Type	Santa Fe	Mallet
Service	Freight	Freight
Fuel	Bit. Coal and Oil	Bit. Coal & Oil
Tractive effort	62,800 lbs.	111,600 lbs.
Weight in working order	287,240 lbs.	616,000 lbs.
Weight on drivers	234,580 lbs.	550,000 lbs.
Weight, engine and tender in working order	466,240 lbs.	850,000 lbs.
Wheel base, total	35 ft. 11 in.	66 ft. 5 in.
Wheel base, engine and tender	66 ft.	108 ft. 1⅝ in.
RATIOS.		
Total weight ÷ tractive effort	4.58	5.52
Weight on drivers ÷ tractive effort	3.74	4.93
Tractive effort × diam. drivers ÷ heating surface	746	967
Total heating surface ÷ grate area	81.98	80.33
Firebox heating surface ÷ total heating surface, %	4.36	4.47
Weight on drivers ÷ total heating surface	48.91	83.60
Total weight ÷ total heating surface	59.9	93.63
Vol. equivalent simple cylinders, cu. ft	17.2	30.2
Total H. S. ÷ cylinder volume	278.85	217.85
Grate area ÷ cylinder volume	3.4	2.71
CYLINDERS.		
Kind	Tandem Compound	Compound
Diameter	19 in. and 32 in.	28 in. & 38 in.
Stroke	32 in.	32 in.
		L. P. 15 in.
WHEELS.		
Driving, diameter over tires	57 in.	57 in.
Driving, thickness tires	3½ in.	3½ in.
Driving journals, main, diam. x length	11 x 12 in.	11 x 12 in.
Driving journals, others, diam. x length	10 x 12 in.	10 x 12 in.
Engine truck, diameter	29¼ in.	34¼ in.
Engine truck journals, diam. x length	6½ x 10½ in.	6½ x 10½ in.
Trailing truck, diameter	40 in.	40 in.
Trailing truck, journals, diam. x length	7½ x 11⅞ in.	7½ x 11⅞ in.
BOILER.		
Style	Extended wagon top	Same
Working pressure	225 lbs.	225 lbs.
Outside diameter of first ring	78¾ in.	79 in.
Firebox, width and length	108 x 78 in.	149⅝ x 78¾ in.
Firebox plates, thickness	Side and crown ⅜ in.	Channel 5/16 in.
	Flue 9/16 in.	Flue 9/16 in.
	Back ⅜ in.	Back ⅜ in.
Firebox, water space	F. 4½", B. 4", S. 5'	F. & B. 5", S. 5½"
Tubes, number and diameter	391—2¼ in.	377—2¼ in.
Tubes, length	19 ft. 11 in.	16 ft. 5 in.
Heating surface, tubes	4,587 sq. ft.	3,625 sq. ft.
Heating surface, firebox	209 sq. ft.	294.5 sq. ft.
Heating surface, feed water heater	——	2,659.5 sq. ft.
Heating surface, total	4,796 sq. ft.	6,579 sq. ft.
Superheating surface	——	2,328.4 sq. ft.
Grate area	58.5 sq. ft.	81.9 sq. ft.
TENDER.		
Wheels, diameter	34¼ in.	34¼ in.
Journals, diam. x length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,500 gals.	12,000 gals.
Fuel capacity	3,000 gals. oil	4,000 gals. oil

* See AMERICAN ENGINEER, Dec., 1909, page 483.

Dynamometer Car of 110,000 Lbs. Capacity

THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY HAS RECENTLY DESIGNED AND BUILT AT THE MILWAUKEE SHOPS, A 36 FT. DYNAMOMETER CAR WITH A MOST SUBSTANTIAL STEEL UNDERFRAME, WHICH INCORPORATES A SPRING DYNAMOMETER OF LARGE CAPACITY.

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Although the oil cylinder dynamometer is generally considered the best suited for this class of work, its advantages are not as great when used with the Mallet compound type of locomotive as with the ordinary simple engine. The former gives a very steady, even pull, is not subject to any considerable amount of slipping and in fact presents conditions wherein the spring dynamometer is reasonably satisfactory, particularly when the very great difference in original cost of apparatus and of the extreme care necessary for its proper maintenance is considered. In the present case the dynamometer consists of two sets of four springs each, the springs being made of 1 3/16 inch bar and having a height of 10 in. when under the initial compression of 100 lbs. Its total compression for the maximum capacity of 110,000 lbs. is 2.17 in. This gives a total movement of 5.42 inches to the pen point.

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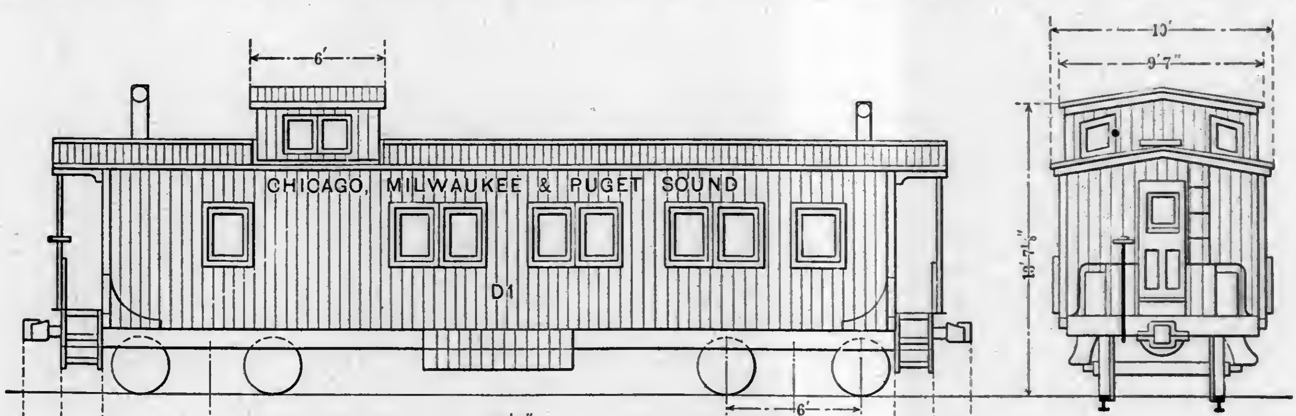

GENERAL DIMENSIONS OF NEW DYNAMOMETER CAR.

original dry pipe. Here the old tee head is replaced by an elbow casting connecting the dry pipe with a steam pipe extension located outside of the boiler. This extension leads to the high pressure section of the superheater, entering the superheater shell to the left of the center line of the boiler. From points near the bottom of the high pressure section of the superheater, steam is led to each high pressure valve chamber by an individual pipe. Exhaust steam from the high pressure cylinders passes through the original exhaust connections of the old saddle. To the original exhaust pipe seat a long vertical exhaust pipe is connected. This pipe extends to the upper shell of the former smoke arch where it joints an elbow connected with a horizontal outside pipe. This pipe, in turn, leads to an elbow connecting with the low pressure section of the superheater. From the low pressure section of the superheater steam is led to the low pressure cylinders by the usual steam pipe beneath the boiler. By the arrangement of steam pipes described, the joints are on the outside where they are readily accessible, facilitating both inspection and repairs. The joints are removed from the intense heat which tends to cause leaks, and in the event of a leak the steaming qualities of the locomotive are not affected.

Both the high and low pressure cylinders are provided with piston valves. The high pressure valve is 13 inches in diameter and the low pressure valve is 15 inches in diameter. The valves on the original locomotives were actuated by the Stevenson valve gear. On the Mallet locomotive the valves of both the high and low pressure engines are actuated by the Walschaert valve gear. The valve motion is controlled by the Ragonnet reversing gear, a device designed by the Baldwin Locomotive Works, and already thoroughly described.

The ten locomotives being converted are to be placed in service west of Winslow, Arizona, and are equipped for burning oil as fuel. The greater evaporative capacity of the firebox applied, together with the application of superheater and feed water heater, provide for the greater power at the cylinders required by the larger locomotive.

The boiler of each original locomotive was fed by two No. 11 lifting injectors, each capable of delivering 3,800 gallons of water per hour. Each Mallet locomotive is equipped with two No. 12 non-lifting injectors, each capable of delivering 4,200 gallons of water per hour.

Compressed air is provided by two 8½ inch Westinghouse cross compound air pumps. The main reservoir includes three drums having a combined capacity of 100,000 cubic inches. One drum is carried on the right side of the rear boiler section and one drum on each side of the front boiler section.

The cab was designed to provide for the comfort of the engine crew when backing up, as well as when going ahead. Because of the unusual length of boiler it was considered best to provide for running the engine backward in case the long boiler should interfere with the vision of the engineer when running forward. In order that the track can be readily seen from the cab, when looking over the tender, the rear end of the tank is tapered in a manner somewhat similar to the incline at the back of switch engine tanks. A clear view past the tender is still further facilitated by rounding the corners of the tank.

The cab is of steel, lined on the inside with wood, in accordance with the usual design on the Santa Fe System. The back of the cab is entirely enclosed by a rear wall of sheet steel and access has been provided by two doors through this wall. Each door provides an opening 21¾ inches wide and the doors are 26½ inches apart. The upper portion of each door contains a pane of glass 15¾ in. x 34½ in. The doors swing open toward the center of the tank and away from the boiler head. In the extreme upper section of the rear cab wall are two ventilators opening 10 x 27 inches. These are closed by swinging sashes.

On the outside of the rear wall, between the doors, a sand box is mounted. This box is made of ⅛ inch sheet steel. It is 22½ inches long, 10½ inches wide by 27 inches deep. A swinging lid permits access to the sand box for filling. A sand valve is connected to the bottom of the box and protrudes into the cab. This valve provides a convenient arrangement for filling the funnel when necessary to sand the boiler flues. The inclined bottom of the sand box directs the sand toward the valve.

There is ample room between the sand box and the oil tank for a man to pass in moving from one side of the tender deck to the other.

The tenders were designed and constructed especially for the Mallet locomotives, the old tenders formerly applied to the original locomotives being assigned to locomotives in other classes. As explained, the contour of the tank is arranged to facilitate a view of the track from the cab when the engine is running backward. A short pilot is attached to the back end of the tender.

The water tank has a capacity of 12,000 gallons and the oil tank a capacity of 4,000 gallons. These are mounted on a built-up underframe of steel carried on two six-wheel trucks. The tender wheel base is 32 feet 6 inches and the trucks are spaced 22 feet between centers. The trucks and underframing are similar in general design to those under the tanks applied to the two passenger and two freight Mallet locomotives delivered to the Santa Fe during the latter part of 1909.*

In addition to the ten locomotives of the Santa Fe type being converted to the Mallet principle, four consolidation locomotives have also just been converted to that type. The general outline followed in converting the 2-10-2 type was observed in converting the 2-8-0 locomotives. The arrangement of feed water heater, superheater, steam connections, etc., is similar, the dimensions of course being modified according to the requirements of the smaller locomotive. The front section is mounted on a two-wheel front truck and four pair of driving wheels, the wheel base arrangement being the same as that of the locomotive converted.

The general dimensions, weights and ratios of the locomotives before and after conversion are given below:

	Original Locomotive	After Conversion
Classes	900 and 1600	3,000
Type	Santa Fe	Mallet
Service	Freight	Freight
Fuel	Bit. Coal and Oil	Bit. Coal & Oil
Tractive effort	62,800 lbs.	111,600 lbs.
Weight in working order	287,240 lbs.	616,000 lbs.
Weight on drivers	234,580 lbs.	550,000 lbs.
Weight, engine and tender in working order	466,240 lbs.	850,000 lbs.
Wheel base, total	35 ft. 11 in.	66 ft. 5 in.
Wheel base, engine and tender	66 ft.	108 ft. 1¾ in.
RATIOS.		
Total weight ÷ tractive effort	4.58	5.52
Weight on drivers ÷ tractive effort	3.71	4.93
Tractive effort × diam. drivers ÷ heating surface	746	967
Total heating surface ÷ grate area	81.98	80.33
Firebox heating surface ÷ total heating surface, %	4.36	4.47
Weight on drivers ÷ total heating surface	48.91	83.60
Total weight ÷ total heating surface	59.9	93.63
Vol. equivalent simple cylinders, cu. ft	17.2	30.2
Total H. S. ÷ cylinder volume	278.85	217.85
Grate area ÷ cylinder volume	3.4	2.71
CYLINDERS.		
Kind	Tandem Compound	Compound
Diameter	19 in. and 32 in.	28 in. & 38 in.
Stroke	32 in.	32 in.
		L. P. 15 in.
WHEELS.		
Driving, diameter over tires	57 in.	57 in.
Driving, thickness tires	3½ in.	3½ in.
Driving journals, main, diam. x length	11 x 12 in.	11 x 12 in.
Driving journals, others, diam. x length	10 x 12 in.	10 x 12 in.
Engine truck, diameter	29¼ in.	34¼ in.
Engine truck journals, diam. x length	6½ x 10½ in.	6½ x 10½ in.
Trailing truck, diameter	40 in.	40 in.
Trailing truck, journals, diam. x length	7½ x 11⅞ in.	7½ x 11⅞ in.
BOILER.		
Style	Extended wagon top	Same
Working pressure	225 lbs.	225 lbs.
Outside diameter of first ring	78¾ in.	79 in.
Firebox, width and length	108 x 78 in.	149⅝ x 78¼ in.
Firebox plates, thickness	Side and crown ⅜ in.	Channel 5/16 in.
	Flue 9/16 in.	Flue 9/16 in.
	Back ⅜ in.	Back ⅜ in.
Firebox, water space	F. 1½", B. 4", S. 5	F. & B. 5", S. 5½"
Tubes, number and diameter	391—2¼ in.	377—2¼ in.
Tubes, length	19 ft. 11 in.	16 ft. 5 in.
Heating surface, tubes	4,587 sq. ft.	3,625 sq. ft.
Heating surface, firebox	209 sq. ft.	291.5 sq. ft.
Heating surface, feed water heater	——	2,659.5 sq. ft.
Heating surface, total	4,796 sq. ft.	6,579 sq. ft.
Superheating surface	——	2,328.4 sq. ft.
Grate area	58.5 sq. ft.	81.9 sq. ft.
TENDER.		
Wheels, diameter	34¼ in.	34¼ in.
Journals, diam. x length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,500 gals.	12,000 gals.
Fuel capacity	3,000 gals. oil	4,000 gals. oil

* See AMERICAN ENGINEER, Dec., 1909, page 483.

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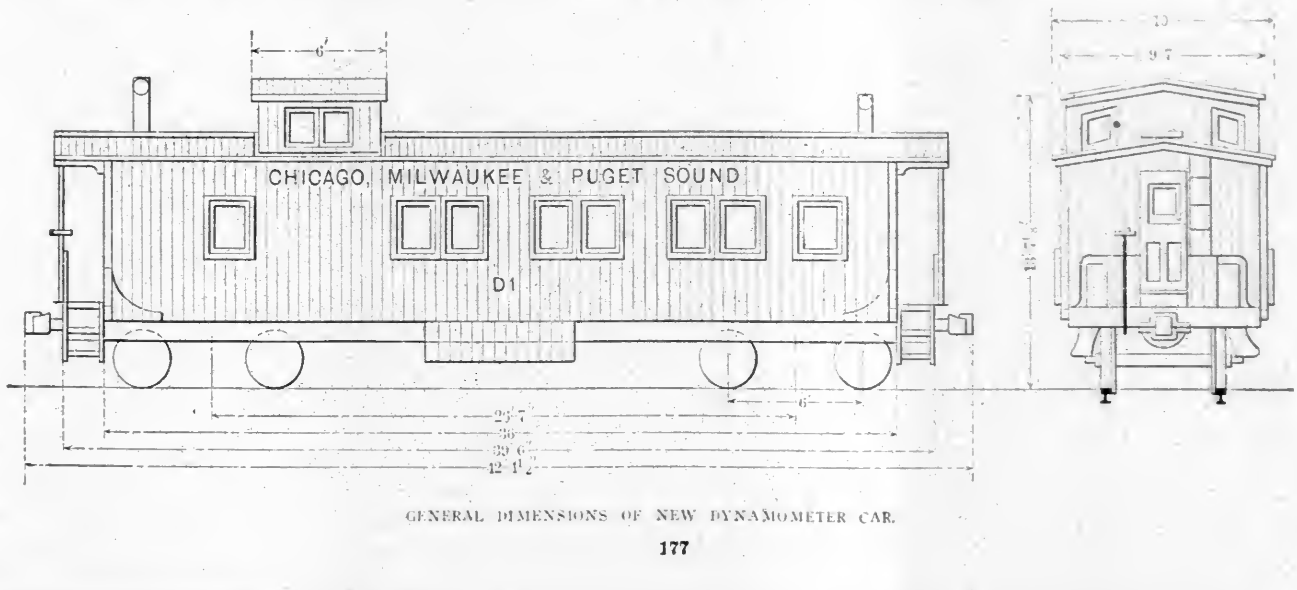
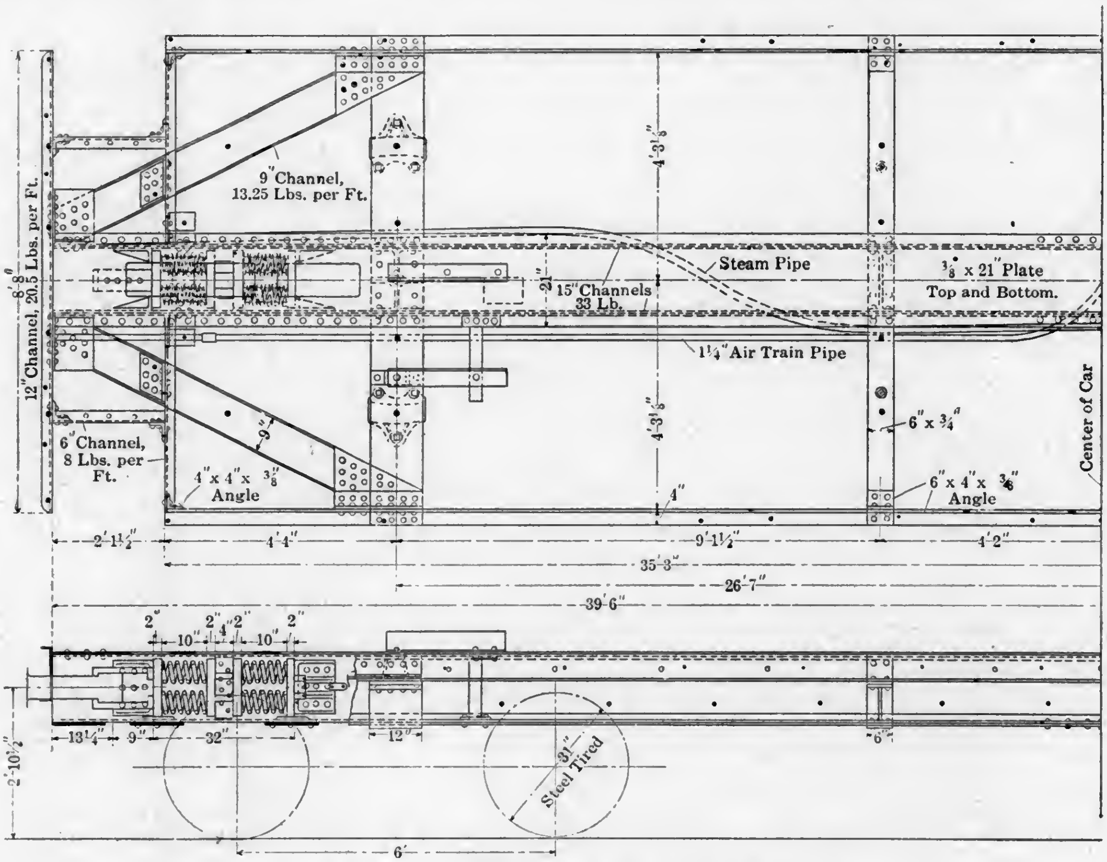


GENERAL DIMENSIONS OF NEW DYNAMOMETER CAR.

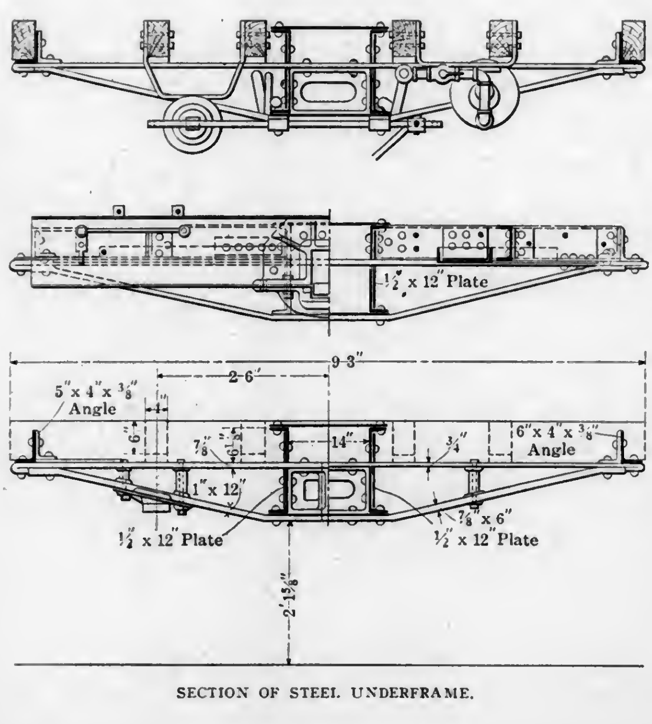
ture of the car is of wood and therefore the remainder of the underframe is of comparatively light construction. The side sills are 6 x 4 x ⅜ in. angles continuous for the full length of the car body and the end sills are 6 in. channels. The bolsters and two cross bearers, spaced equally between, are of the simple truss type, the bolsters having a ⅞ x 12 in. tension member and a 1 x 12 in. compression member. The cross bearers have a ¾ in. top plate and a ⅞ in. bottom plate 6 in. in width. The upper members of both the bolsters and cross bearers pass through openings cut in the center sill channels and a stiffening and reinforcing casting is inserted at this point.

Supported on this steel underframe are six longitudinal wooden sills, 4 x 6 in. in section. These are securely bolted and fastened to the steel members, especially to the side sills, and on this is erected a wooden superstructure of the customary light passenger car type.

The paper driving mechanism consists of a bronze bushing, incorporating a 6 in. diameter gear, keyed to the inner axle of



VERY HEAVY STEEL UNDERFRAME ON NEW DYNAMOMETER CAR.



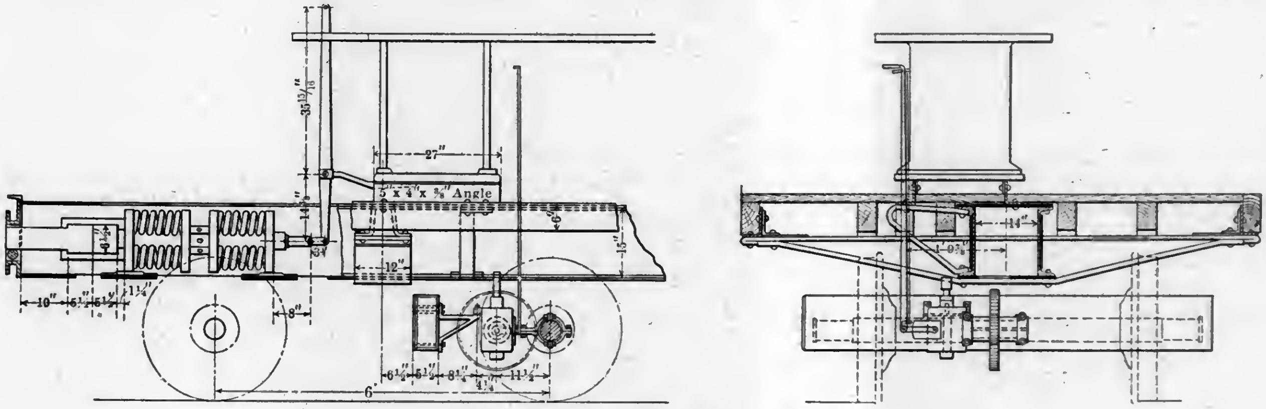
SECTION OF STEEL UNDERFRAME.

the truck at the dynamometer end of the car. This pinion meshes with a 17 in. gear keyed to a short shaft on which is carried a small bevel gear enclosed in the reversing box. This shaft and the other mechanism is carried in a frame supported on the bronze bushing on the axle and a bracket extending out from the truck frame, as is shown in one of the illustrations. On the vertical driving shaft there are two bevel gears, both in mesh with the one just mentioned and running free. Between them there being a clutch to engage the proper one to give the correct movement of the paper roll. A universal joint is placed in this shaft just above the floor of the car to take care of the effect of the movement of the truck and above this joint are the worms driving the paper rolls in the customary manner, this of course being on the recording table frame. The axle to which this mechanism is connected carries 30⅞ in. steel tired wheels and the construction is such that the vertical shaft makes 234.2 revolutions per mile, giving 4.4 ft. movement of the paper in that distance.

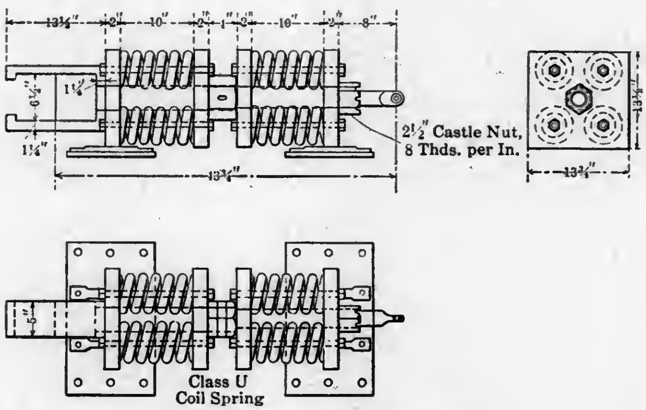
The pull from the coupler shaft is carried to the dynamometer by means of a large steel shaft in the center between the springs, the inner end of which is linked to a vertical rod, which is pivoted so as to give a 2½ in. movement at the upper end for a 1 in. movement of the draw bar. The upper end is connected through a link with the customary straight line pen carrying bar supported in guides over the top of the recording table.

On the recording table are instruments for making six records on the roll. At one side is the pen connected to the chro-

nometer, which receives an impulse at five second intervals and gives the speed data. Next to this is a pen operated by a circuit from the cab by means of which the throttle and reverse lever positions are recorded. Next comes the pen giving datum line for determining the draw bar pull adjoined by the record of the movement of the coupler itself. These two records are, of course, in the center of the sheet. On the opposite edge is a pen controlled by a circuit from the cab giving an indication of when cards are taken. Above this is the pen controlled from the lookout, by which all mile posts, stations and other permanent objects along the right of way are indicated. All of this apparatus on the recording table is most substantial and accurately constructed.



CONNECTION FOR RECORDING APPARATUS.



DETAILS OF SPRING DYNAMOMETER.

Altogether the car is but 36 ft. in length, the arrangement is such as to make it very roomy while at the same time including such conveniences as are practically necessary on a car of this character. There are four upper and two lower berths; plenty of storage space and a coal stove arranged for cooking if necessary.

The trucks under the car are of the standard arch bar type of heavy and substantial construction, the bolsters being very rigidly built of steel plates and angles and carried on four double elliptic springs. The axles are M. C. B. 60,000 lbs. and the wheels measure 30⅞ in. in diameter. The car has a total weight of 53,100 lbs.

ANNUAL CONVENTION OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION.—The third annual convention of this association will be held at Chattanooga, Tenn., May 15 16, 17 and 18, 1911. Hours of session from 9 A. M. to 1 P. M. daily, excepting May 17, when there will be morning and afternoon sessions. Subjects of papers for reading and discussion: "Fuel Investigations Under the Bureau of Mines," Dr J. A. Holmes, chairman, director Bureau of Mines; "How to Organize a Railway Fuel Department and Its Relations to Other Departments," T. Duff. Smith, chairman, fuel agent Grand Trunk Pacific Railway; "The Testing of Locomotive Fuel," F O. Bunnell, chairman, engineer of tests Rock Island lines; "Standard Locomotive Fuel Performance Sheet," F. C. Pickard, chairman, A. M. M., C. H. & D. Ry.; "The Railway Fuel Problem in Relation to Railway Operation," R. Emerson, chairman, engineer track economics A. T. & S. F. Ry.; "Petroleum, Its Origin, Production and Use as Locomotive Fuel," E. McAuliffe, chairman, general fuel agent 'Frisco lines.

ELECTRIC LOCOMOTIVES FOR PANAMA

Tenders are being invited for electric locomotives of a unique type for service on the Panama Canal. They will be run on a rack railway and be put to the duty of towing vessels through the waterway. In the design formulated by the Isthmian Commission these towing locomotives are shown for construction in three sections, of which the front and rear are to be mounted on rigid four-wheel trucks, each driven by an independent motor, while the middle section is connected to the two tractive elements by universal joints, and is equipped with a slip-drum towing windlass and hawser, so that the line may be veered and hauled at pleasure without any motion of the locomotive along the track.

In towing, the locomotive derives its tractive effort from one of the end elements through a pinion engaging a shrouded semi-suppressed rack anchored in the coping. The side pull of the hawser is taken up by horizontal thrust wheels which bear on the side of the track. The current for the operation of the locomotives will be taken from underground circuits. The maximum pull on the tow line is fixed at 25,000 lbs., at which force a friction coupling will relieve further strain. The central racks are to be provided only on the towing tracks and inclines. On the level portion of the return tracks the locomotives will run by friction on the side rails after the fashion of the ordinary electric railway.

THE MAXIMUM EXPORT OF STEEL RAILS was reached in 1904, when 414,845 tons, valued at $10,661,222, were sent to foreign countries. The year of next largest exportation was 1900, in which year we sent to foreign lands 356,245 tons, valued at $10,985,106. Last year, which was the third largest year in our steel rail export trade, there were 353,180 tons of rails sent abroad, the home value of which was $10,162,522. The average value per ton of the rails exported in 1904 amounted to only $25.70, while in 1910 the average value was $28.77 per ton, a difference of $3.07. In each of these years the price of steel rails at mills to domestic consumers was $28 per ton.

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ADVERTISEMENTS—Nothing will be inserted in this journal for pay, **except in the advertising pages.** The reading pages will contain only such matter as we consider of interest to our readers.

CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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CONTENTS

WHAT NEXT?

A driving wheel base of about 20 ft. and an average weight per axle of 55,000 lbs. would both be practically a maximum on most roads. When you take a Mallet type locomotive, both groups of drivers having this wheel base and average weight per axle, it would seem as if the maximum weight locomotive had finally been reached. Of course, every one knows that this is not the case because nearly every one has been fooled a number of times in the past by believing that the limit had finally been reached. It would seem, however, that the limit with the Mallet had now practically been achieved by the new converted Santa Fe locomotives illustrated in this issue and that further decided increase in weight must be accompanied by a new type. What will it be? Who will venture to predict? Please send answers to the puzzle department.

THE CONVENTION SEASON

Beginning with the first of May the open season for conventions of associations in the various lines of activity in the railroad motive, power department arrives, not to close until the middle of September. During this time there are conventions of associations of blacksmiths, boiler makers, tool foremen, general foremen, fuel agents, storekeepers, traveling engineers, master car builders, and master mechanics.

Some department managers doubt the wisdom of sending their men to the conventions of the associations with which they should be affiliated, basing their decision largely upon a perusal of the printed proceedings. It must be admitted that taking all of the various proceedings of the associations together that there is comparatively little wheat mixed with an enormous amount of chaff and that if this was all that could be gained by an attendance at the convention such a decision would be proper. As a matter of fact, however, opportunity to mingle and become acquainted with men whose interests are identical with their own, the exchanging of ideas and experiences, the opportunity of examining at leisure the latest appliances particularly adapted to their trade, and the original ideas brought to the surface by a discussion of the various subjects, far outweigh in value the information as presented in the printed papers and printed discussion. These conventions can be and usually are of the utmost value and importance to the railroad companies and the employees who ought to be affiliated with each, should not only be urged to attend the conventions, but should be ordered to do so.

It is recalled in this connection that on a prominent Eastern railroad some few years ago, on the occasion of a Master Mechanics' Association Convention, that one man was selected as a representative of the entire railroad. On that same railroad last year every master mechanic attended at the request of the general manager. This change of front is a move decidedly in the proper direction, and one which cannot but prove to be equally gratifying in the long run to both the management and to the recipients of the privilege.

POORLY ARRANGED LOCOMOTIVE DETAILS

The undeniable fact that the American locomotive is some one hundred per cent. more complicated than it was fifteen or twenty years ago is a feature greatly to be deplored, notwithstanding it may be logically offered that such complication has been found unavoidable as the development of the machine progressed. It is not so much the increased number of parts which need be viewed with concern, but rather the practical inaccessibility, in many instances, on a single engine of their connecting details, which necessarily must be in receipt of constant attention.

A mere superficial examination of any of the recently turned out engines of larger type will convincingly attest to the extremes to which burying parts which have to be worked on

possibly every day have been carried. An instance is before us at this writing where it would be necessary to drop the rear driving wheel on a 4-6-0 engine to remove the back driving spring, no provision having been made in the design to allow sufficient space between the boiler and the driver to pull it back and out on the tender after being disconnected. In another the back motion eccentric must be removed from the axle to tighten the set screws in the forward motion, because the set screws had been located within the eccentric instead of clear of it in the extension for more bearing on the axle, where they could be readily reached with a socket wrench. On a recent consolidation engine the main air reservoir was observed to be placed behind the cylinders, and tight up against the boiler jacket, so that for its removal the heavy engine truck equalizer and the cross equalizer and its hanger must all come down

Instances of poorly located minor parts, and particularly carelessly run piping, which in many cases must have several tight joints broken to permit the simple tightening of nuts behind it, are innumerable. On a recently inspected engine we found that in order to apply a new right hand sliding fire door to the door frame it would be requisite as a preliminary to remove the reverse lever and quadrant, all piping from the engineer's brake valve, and the overflow and feed pipes from the right injector, both injectors happening to be on the back head of the boiler.

It may be that the location of these things is the result of careful consideration, and is the best that can be done under the circumstances, but instances indicating the contrary are so plentiful and so flagrant that we are inclined not to believe it. We do not think that the running repair phase of the situation is viewed at its true importance; in other words, that the location of the minor parts is frequently determined upon without reference to their easy accessibility to repair. It does not appear that those in the drawing office are familiar with running repair jobs in their order of rotation, and do not appear to have a full realization of the fact that while a part may never have to come down for any repairs to itself, it may still be removed three or four times a week to allow something else to be worked on. Thus the fatal error is easily fallen into of making these parts which are known not to require any repairs as permanent an institution on the locomotive as it is possible to do.

For instance, a dome casing never needs any repairs in the lifetime of the engine, but the dome cap which it covers sometimes has a leaky joint, and frequently has to come off for that and for work on the throttle valve. In attempting to get to it, however, the man doing the job is often confronted by a dome casing made of two pieces in this fashion: the lower section a cylinder of heavy planished iron, surmounted by a heavy, rounded cast iron top piece into which it fits with the accuracy of watch work, and is further secured by some half a dozen machine screws tapped through into the dome proper. Last, but not least, the heavy top piece mentioned has no provision for taking hold of it with a tackle, and must be handled by hand, and on a very precarious foothold, as we all know.

Of course, it is needless to add that these things, of which infinite examples abound, are decidedly wrong. They represent the combination of ignorance and lack of forethought which is a positive injustice to the roundhouse force. That the work of the latter at its best is far from being entirely agreeable needs no comment here, and these errors of judgment in the design and assembling of parts, which double the labor required for the job itself, can do nothing other than breed the spirit of discontent. That dome casing referred to would be every bit as serviceable if made of one piece, dropped over the dome, and held from moving by a tap bolt in the center of the top screwed into the dome cap.

We have had long experience with roundhouse men of all trades, and we know them to be peculiar in this way. They are perfectly willing to do any job to which assigned, but we never saw one yet who would not murmur over doing a preliminary job of greater proportions before he could get to the one he was after, and to which he had been assigned. In consequence, when that job is finally reached, the man is disgusted, and it is an even chance that the work will not be scarcely half as well done as it would have been if he could have reached it at first hand. When a road has a number of these inaccessible engines in one roundhouse it is in a truly unfortunate position from the standpoint of keeping its men satisfied and in accord with its mechanical ideas. The shop men do not like to work on these engines and they are not in sympathy with them. It may be emphasized in this connection that there is nothing which operates more to the detriment of general efficiency than the lack of sympathetic accord, whether exhibited on the road or in the shops.

These features of inaccessibility in the location of parts have gone far toward defeating and condemning many a device in possession of great intrinsic merit, and inventors as projectors of all new appliances destined for locomotive use should bear the fact prominently in mind. Judging from many devices which we have studied they are not doing so now, not at least to any extent. If it is hard to take apart or put together it will receive its sentence in the very first shop it is worked on as "no good," with, of course, the explanation why it is so designated, but unfortunately the next man will forget these reasons, and it will simply be "no good" without the redeeming explanation. Thereupon the verdict flies fast, and is too often accepted with little or no inquiry.

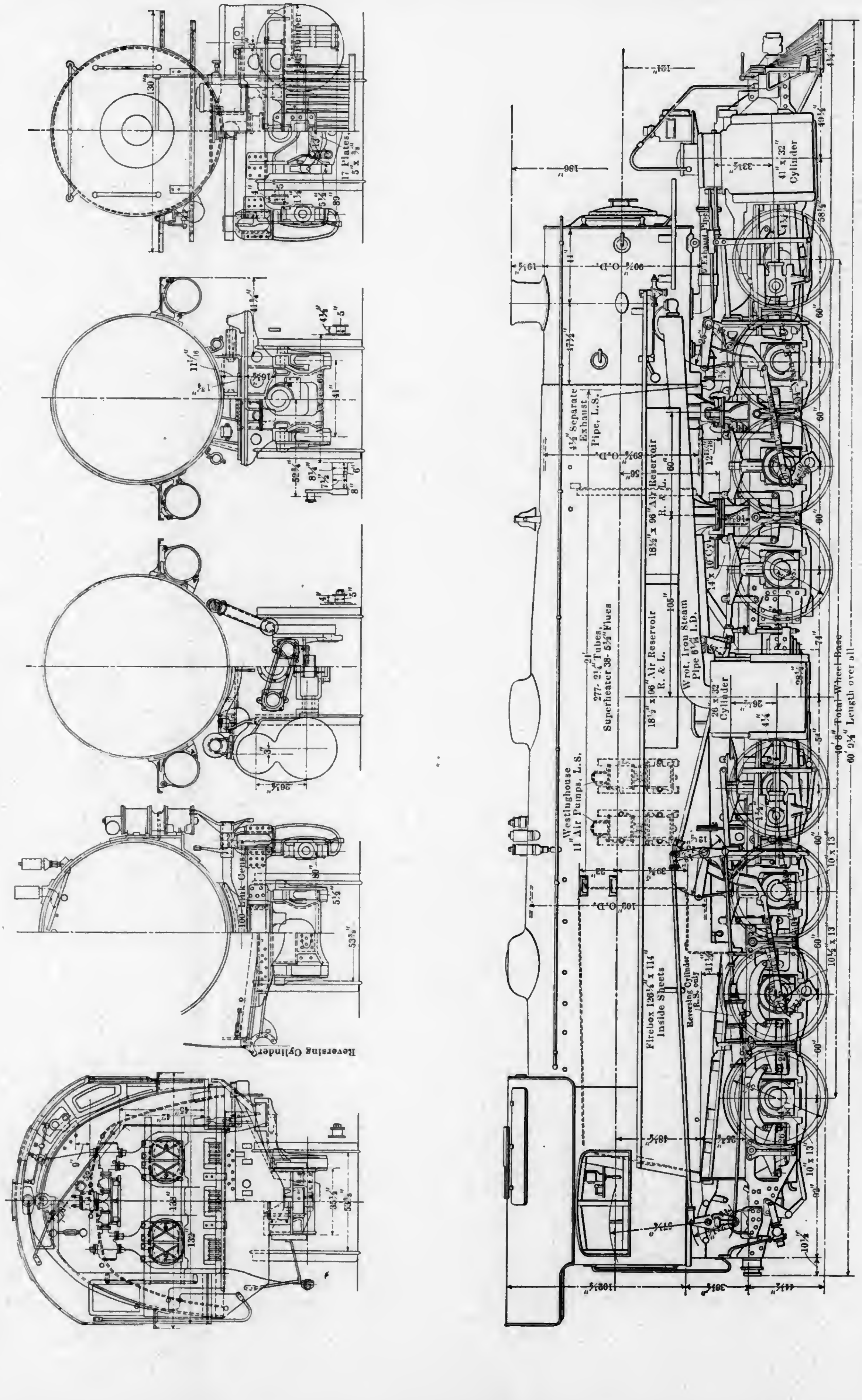
From the standpoint of the shop, the original Vauclain four-cylinder compound principle as applied to a 2-8-0 type locomotive was "no good" for the following reasons: in that construction, on account of the low frame it became necessary to cast the cylinders with the low pressure on top on account of insufficient clearance between it and the track if on the bottom. This in turn necessitated the valve chamber being on the bottom, on the same horizontal plane with the high pressure cylinder, a position which put the center of its head immediately behind the engine truck wheel.

These engines were quite destructive to valve packing rings, and were practically worthless on the side which had any rings broken. The valve was very easy to pull out and the rings could be renewed in less than an hour, but unfortunately it would come only half way out of the chamber before bringing up against the engine truck wheel. Thus, what would apparently on the start prestige a respectable job became at once endowed with fearful complications; i. e., the pilot must be taken off, engine jacked up, engine truck equalizer disconnected and truck rolled from under.

It would be expecting too much from human nature for a man to repeatedly take kindly to this farce, so if it must be written, many an engine left the shop with only the front rings of the valve renewed. The percentage was probably twenty front renewals to one entire renewal. Under the eye of the master mechanic, of course, the whole laborious process as outlined was resorted to, but the real damage through neglected renewals was done at night when the force was limited and the supervision reduced to one foreman, who often willingly condoned the half done job in preference to tying up one of his gangs on a single engine all night.

This is the real menace in inaccessibility of common repair parts. There is always a great pressure of work in a roundhouse, and if the parts are very hard to get to and, unless the foreman and his men are absolutely conscientious, the temptation is almost irresistible to let the job go until the "next time," which, needless to add, never comes.

In this consideration we do not deny that extreme cases have been cited as illustrations. Some of them possibly could not be avoided, but there are hundreds of mean, petty propositions along the same lines which a little more care in location and design would effectually have eradicated. There is no need to provide obstacles tending to make unpleasant work even harder than it must be, and it is poor judgment to place the incentive in a man's way to slight it. It is confidently believed that a more intelligent handling of this very important detail will work wonders in increased locomotive efficiency, because, if the work can be reached, in nine shops out of ten it will be done, while now in many cases the peculiar construction is such that they couldn't do it if they wanted to.



MALLET LOCOMOTIVE DESIGNED ON THE BASIS OF SEVEN YEARS EXPERIENCE WITH THIS TYPE ON THE BALTIMORE AND OHIO RAILROAD.

Mallet Locomotive With Superheater 0-8-8-0 Type

BALTIMORE & OHIO RAILROAD.

AMONG THE LATEST PRODUCT OF THE AMERICAN LOCOMOTIVE COMPANY ARE TEN MALLET COMPOUND LOCOMOTIVES FOR THE BALTIMORE & OHIO RAILROAD, WHICH HAVE A TOTAL WEIGHT ON DRIVERS OF 461,000 LBS. AND A TRACTIVE EFFORT OF 105,000 LBS. THESE ENGINES ARE EQUIPPED WITH SCHMIDT SUPERHEATERS.

At the St. Louis World's Fair in 1904 there was a locomotive forming part of the magnificent exhibit of the Baltimore & Ohio Railroad which, next to the locomotive testing plant, was the center of attraction for motive power men from all over the world. This ponderous machine was viewed with amazement by foreign visitors and with critical interest by American railroad men. "Monstrosity" was the term often applied to it; other exclamations were "an absurdity," "freak," "never will stay on the track," "cannot keep the steam pipes tight," etc. That locomotive weighed 334,500 lbs. and was the first Mallet type to be built in this country. At that time it had not been in service, having just been delivered to the Baltimore & Ohio Railroad by the American Locomotive Co., and every one could express his opinion of it untrammeled by facts.

That practically every one was wrong in their snap judgment probably is best illustrated by the fact that now, but seven years later, the same company is receiving from the same builders ten locomotives of the same type, which are nearly 50 per cent. more powerful and 38 per cent. larger on the basis of weight. There is now no doubt in the mind of anyone but what these engines will be a success.

A comparison of these two locomotive designs, seven years apart, is an excellent illustration of the progress in locomotive building in this country during that time. Reference to the table on the next page will show what has occurred. Taking everything into consideration there is an increase of about 40 per cent. in the seven years.

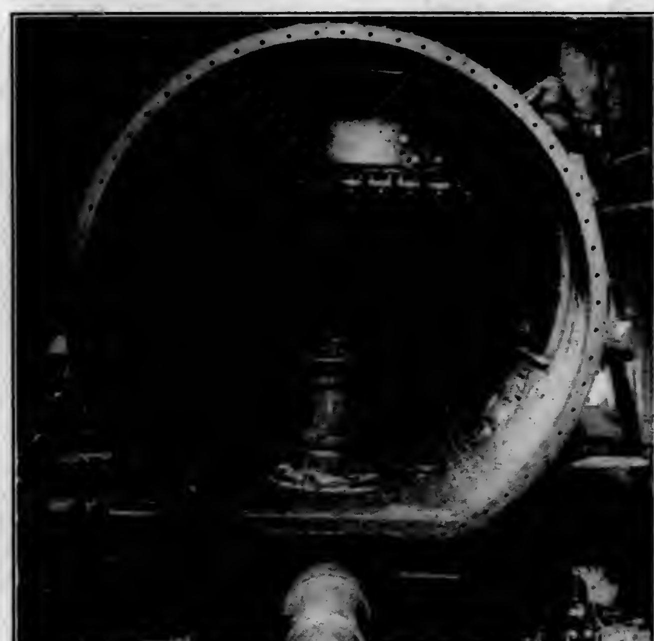
Experience with Mallet compound locomotives almost from the beginning indicated that trouble could be expected from wet steam in the low pressure cylinders, and it is now becoming quite general practice, on the largest examples at least, to apply superheaters, which not only correct this trouble, but also give a decided economy in the high pressure cylinders. On the Santa Fe it has become the custom to apply a low degree superheater ahead of the high pressure cylinders and then reheat the steam in another superheater before passing it to the low pressure. In the present instance, however, a Schmidt high degree superheater is employed, furnishing sufficient superheat before the steam enters the high pressure cylinders to prevent any condensation in the low pressure. In this case the superheater is of the single loop system and contains 1,000 sq. ft. of heating surface in 152 1⅜ in. tubes.

NEW LOCOMOTIVE ON THE B. & O. R. R. FITTED WITH SCHMIDT SUPERHEATER.

It will be noticed that after seven years experience with a Mallet locomotive without front or rear trucks that the Baltimore & Ohio Railroad has decided in favor of this construction and the present locomotives are of the 0-8-8-0 type.

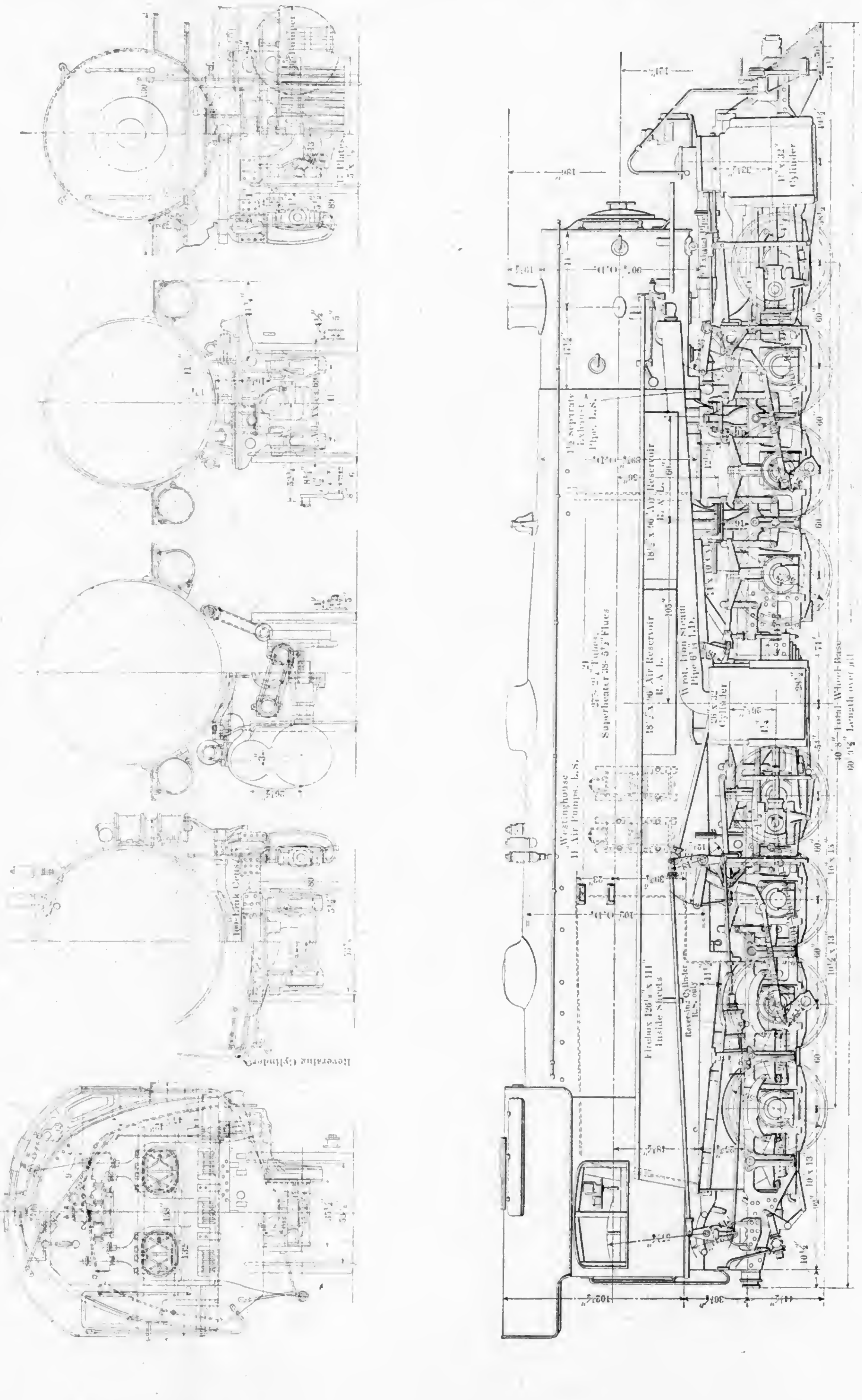
With the exception of the locomotives of the 2-10-10-2 type on the Santa Fe, illustrated elsewhere in this issue, these engines have the greatest weight on drivers of any on our records. The weight per axle is 57,625 lbs. and is carried on 10 x 13 in. journals, the main journal being 10½ in. in diameter. This gives an average pressure of about 219 lbs. per sq. in. on the brasses.

The boilers on these locomotives, which are very similar to the design applied for the Dalaware & Hudson Company,* are the largest ever constructed wherein the whole is evaporating heating surface. They measure 90 in. in diameter at the front ring and 102 in. at the connection. The tubes are 24 ft. in length and a combustion chamber 38 in. long has been incorporated. The use of the high degree superheater requires the carrying of the steam forward in a dry pipe in the customary manner



VIEW IN FRONT END SHOWING SUPERHEATER. THE STEAM PIPES ARE NOT IN PLACE.

* See AMERICAN ENGINEER, June, 1910, page 207.



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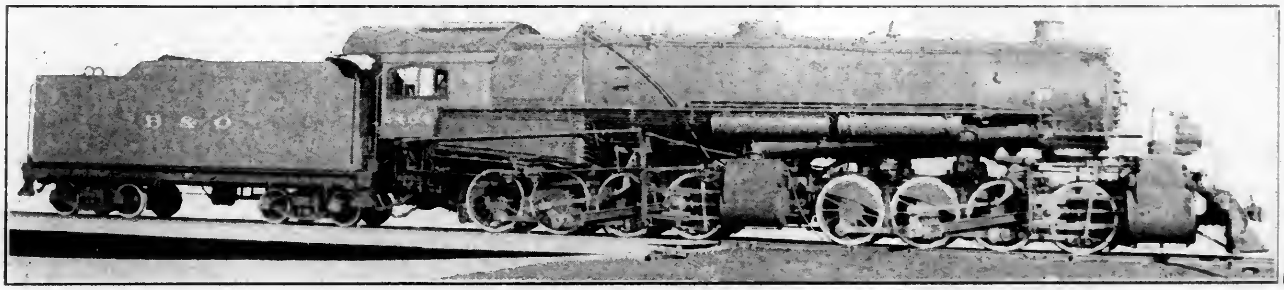

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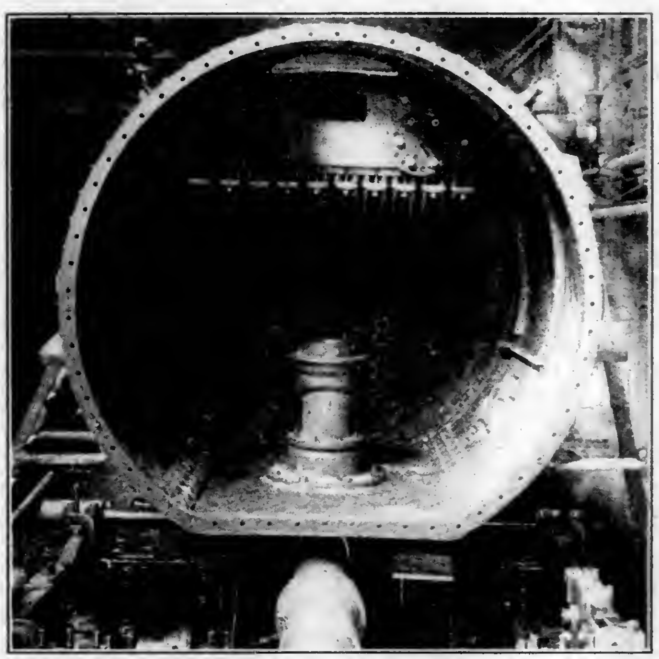

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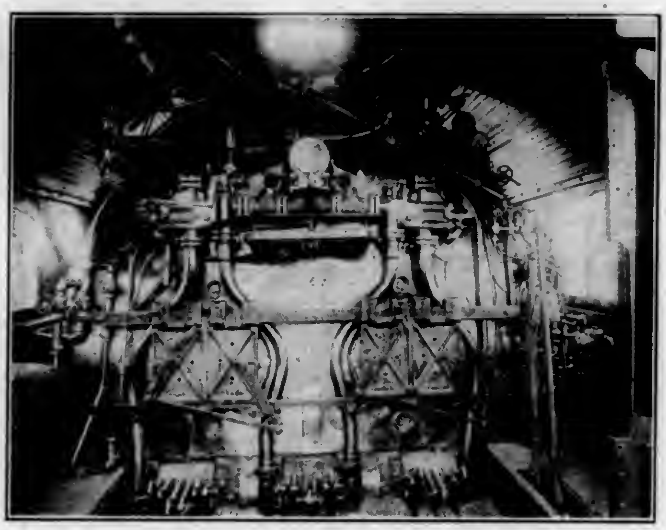
for a simple engine and outside steam pipes extending from the front end to the high pressure cylinder. This same arrangement was followed on the Delaware & Hudson engine, although no superheater was there employed, because of it being inadvisable to use outside steam pipes from the dome on so large a boiler. The pipes in this case are 6 in. inside diameter wrought iron pipes and are arranged with a slip joint at the elbow connecting into the high pressure steam chest. They are, of course, very heavily lagged and carefully supported to the boiler shell. A surge plate, with enlarged openings for the tubes to pass through, is located about 54 in. back of the front tube sheet.

	1904	1911	Increase Per Cent.
Type	0-6-6-0	0-8-8-0	....
Total weight (on drivers)	334,500	461,000	38
Tractive effort	70,000	105,000	50
Cylinders, diameter	20 & 32	26 & 41	30
Cylinders, stroke	32	32	....
Steam pressure	235	210	11*
Diameter drivers	56	56	....
Tubes, number and diameter	436—2¼	277—2¼	36½*
Tubes, length	20 ft. 10 in.	24 ft.	20
Tubes, heating surface	5,380	5205.5	3¼*
Total heating surface	5,600	5,526.9	1⅓*
Equivalent heating surface	5,600	7,029.9	25
Grate area	72.2	99.9	38.3
Wheel base, driving	30 ft. 8 in.	40 ft. 8 .ni	33
Wheel base, engine and tender	64 ft. 7 in.	77 ft. 2¾ in.	19
Tender, water capacity	7,000	9,500	35
Tender, coal capacity	16	16	....

* Decrease.

TABLE SHOWING PROGRESS IN LOCOMOTIVE DESIGN ON THE B. & O. R. R.



INTERIOR OF CAB, NEW B. & O. MALLETS.

The feed water disharge, which enters through an internal pipe, is close to the front tube sheet.

These locomotives are in many ways similar to the ones on the Delaware & Hudson mentioned above. The tractive effort is the same in both cases, although the Baltimore & Ohio engine has 4 in. greater stroke, which is off-set by the drivers being 5 in. larger in diameter and the steam pressure 10 lbs. less.

One of these engines has been fitted experimentally with a Crawford stoker having three troughs.

The drawings and photographs show the details of construction and the general dimensions, weights, ratios, etc., are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	105,000 lbs.
Weight in working order	461,000 lbs.
Weight on drivers	461,000 lbs.
Weight of engine and tender in working order	642,500 lbs.
Wheel base, driving	40 ft. 8 in.
Wheel base, total	40 ft. 8 in.
Wheel base, engine and tender	77 ft. 2¾ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.4
Total weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ equivalent heating surface*	837.00
Total heating surface ÷ grate area	55.00
Firebox heating surface ÷ total heating surface, per cent	5.80
Weight on drivers ÷ total heating surface	83.20
Volume equivalent simple cylinders, cu. ft	29.7
Equivalent heating surface* ÷ vol. equiv. cylinders	237.00
Grate area ÷ vol. equiv. cylinders	3.36

CYLINDERS.

Kind	Mellin Compound
Diameter	26 and 41 in.
Stroke	32 in.

VALVES.

Kind, H. P	Piston
Kind, L. P	D. P. Slide
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance, H. P	5/16 in.
Inside clearance, L. P	⅛ in.
Lead	3/16 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10½ x 13 in.
Driving Journals, others, diameter and length	10 x 13 in.

BOILER.

Style	Conical
Working pressure	210 lbs.
Outside diameter of first ring	90 in.
Firebox, length and width	126 3/16 x 114 in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-5", B-4", S-4½ in.
Tubes, number and outside diameter	277—2¼ in.
Tubes, length	24 ft.
Superheater fire tubes, No. and diameter	38—5½ in.
Superheater steam tubes, No. and diameter	152—1⅛ in.
Heating surface, tubes	5,205.5 sq. ft.
Heating surface, firebox	321.4 sq. ft.
Heating surface, total	5,526.9 sq. ft.
Superheater heating surface	1,002 sq. ft.
Grate area	99.9 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 6 in.

TENDER.

Tank	Waterbottom
Frame	10 and 15 in. channels
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,500 gals.
Coal capacity	16 tons

* Equivalent heating surface equals total heating surface plus 1.5 times superheater heating surface.

A TRAVELING STOREHOUSE

The stores department of the Atchison, Topeka and Santa Fe Ry. at Topeka, Kansas, has recently inaugurated the traveling storehouse method for handling supplies. It if proves to be the success expected, it will be extended to points on the system other than the coast lines where it is now being tried out.

A new supply car, recently completed in the shop at Topeka, is to be started from a given point on the first day of every month. Shelves, pigeonholes and other receptacles are arranged in such a manner as to greatly facilitate the handling of small materials and stationery. For conveying larger and heavier material additional flat cars attached to the main supply car are used. On receipt of requisitions for repairs and renewals the storekeeper will assemble and load on the cars sufficient material for the main line covering track tools, frogs, switches, cattleguards, farm gates, fence wire, staples, spikes, bolts—in fact, all items for renewals aside from complete bridges or buildings. After loading has been completed the flat cars containing the heavier material will be coupled in ahead of the main supply car in a regular train. It will probably require six or eight cars to transport satisfactorily all the material required for a single trip.

At present it is the intention to cover the Albuquerque, Arizona and Los Angeles divisions only, and, if it is found possible to cover the entire coast lines once a month, arrangements for an extension of this new method will be made accordingly. The operation and development of this new way of collecting, transporting and delivering supplies will be watched with interest all along the line. On a previous trial with a temporary car on five divisions of the system it was found that a saving of over three thousand dollars a month was made on the various items carried at that time, and it is expected that, through the co-operation of other departments, when the details of the present trial are worked out, an even greater saving in time and money will have been accomplished.

ELECTRIFICATION IN BOSTON

Two years ago a very elaborate report was made by a commission which suggested a complete rearrangement of all railroad terminals in the city of Boston and involved the construction of a tunnel which rendered electric operation necessary. This report was referred to a joint commission, which last year submitted a preliminary report to the legislature, recommending that it request the railroads to make investigations and studies with reference to electrification. The legislature, however, amended the report by requiring the commission to present with its report a draft of a bill which should compel the electrification of all steam railroads in the metropolitan district within a stated time. The railroads made a report to the joint board last November and the commission had but two months in which to study the subject and present its report to the legislature. In this report, made last January, it advised against any compulsory legislation, but the opinion was not unanimous except in that particular.

At the March meeting of the New York Railroad Club, being the seventh annual electrical night, Professor George F. Swain, department of engineering, Harvard University, who was a member of this commission and a signer of the majority report, presented in a very clear manner the line of reasoning which led to the conclusions as reported by the majority. Mr. Swain spoke in part as follows:

The so-called metropolitan district comprises a number of cities and towns in the neighborhood, and is bounded simply by the boundaries of those towns and cities. It, therefore, comprises an irregular area around the State House in Boston extending from ten to fifteen miles and in a few instances perhaps twenty miles out. The average distance is only ten or fifteen miles from the center. There are three main systems of railroad entering Boston: The N. Y., N. H. & H. System enters from the south and southwest; the Boston & Albany from the west; and the Boston & Maine from the north and west. There are some twenty-one different branch lines of these three systems comprised within the so-called metropolitan district; and a compliance with the compulsory legislation suggested by the last legislature would have required the electrification of these twenty-one the whole or parts of various lines, some of which form loops, extending as I said from ten to fifteen miles from the center of the city.

Now, you will observe that that is an entirely different problem from that which exists in New York City. Here you have the New Haven and New York Central roads running almost north from the terminal station, with only three branches, whereas in Boston we have some twenty-one branches to consider.

Now, the reports from the railroad companies indicated the cost and the various elements which entered into the problem around Boston. We are all of us agreed, undoubtedly, that we would like electrification. The Boston public is no different from the New York public, or the Chicago public or the public of any other large city in that respect. The advantages are undeniable. The reduction of smoke; the increased distance which can be covered in a given time, owing to the quick acceleration of electric trains; and the increasing value of property in the vicinity of the roads owing to the noiseless operation, and the absence of smoke and dirt, are three great advantages to the public. There are also, of course, advantages to the railroad companies, and unquestionably economies can be effected. The saving of coal by electric operation is undeniable; the saving of repairs is undeniable; the saving in corrosion of overhead structures, due to escaping smoke and gases from locomotives is also undeniable. Then there are economies which may in some cases be effected by utilizing the space over tracks for building. Whereas no use can be made of the space over the tracks of a steam railroad, it is possible to utilize the space over electric stations for office buildings, or for buildings of many sorts, in large cities. But that, however, is a real estate problem. In some cases it may prove to be a source of economy, while in other cases it would not be, because no such investment of capital would be justified. Then the economies in the saving of switching by the use of multiple unit trains is undeniable. So that in electrification everybody admits that there are great advantages for the public, and for the railroad companies as well.

On the other hand, electrification is very expensive. The question is whether it is wise to attempt to secure by legislative compulsion a thing which we all want to have, independent of the question whether it can be secured with ultimate resultant economy to the public. As I said, the board in Boston concluded that it was not wise to recommend any compulsory legislation.

Now, I think that most people are fair-minded and if they have the facts clearly presented to them, that they will not be consciously unfair in arriving at their conclusions. But I think most of us, and indeed all of us, are apt to make mistakes in reasoning from facts, or to base our conclusions upon insufficient facts. I think among the public in general there is a great deal of misapprehension with reference to electrification. And I think we have too many people who believe, because they want a thing, that this is sufficient ground for demanding it, especially if they can make somebody else give it to them for nothing.

Now, as I have said, the conditions in Boston are very different from those in New York. There are some twenty-one lines radiating from the center, extending out fifteen or twenty miles to the limit of the metropolitan district. The reports from the railroad companies indicated that the cost of electrifying the principal lines in the metropolitan district would be $40,000,000, for the passenger traffic alone—of course, for freight traffic there would be a considerable addition to that expense, and unless electrification were applied to both the freight and passenger traffic its advantages to the public would be materially reduced. $40,000,000 is a very large sum of money for the State to require the railroads to expend. Furthermore, the expenditure of this large sum would only electrify these various lines for an average distance of twelve or fifteen miles out.

Now, in New York City with the expenditure of half that sum, or about $22,000,000, the N. Y. Central and New Haven Companies have electrified their lines twice as far, or for a distance of thirty or more miles out, embracing a large part of their suburban traffic.

It is very expensive to electrify the stub ends of a number of lines. I think that is where an unjust comparison is often made. Boston people come to New York and seeing what is done here, they say if the New York railroads are able to give that service, they don't see why the Boston lines ought not to be compelled to give it. Of course, the electrification of an entire railroad presents a very different problem from electrifying only twelve or fifteen miles on one end of a steam road. In the latter case not much saving is effected on the steam operation, while the cost of electric operation is added. The steam locomotives have to be disconnected ten or fifteen miles out, and the trains are hauled from that point in by electric locomotives. The expense of steam operation is not materially reduced, while the expense of electric operation within the electric zone is added. If an entire railroad or an entire locomotive division could be electrified resultant economies could perhaps be secured. This is a very different thing from electrifying the stub end of a road.

The metropolitan district includes among the 21 lines I have mentioned some which join main lines just within the limits of the metropolitan district, which were left out in the estimates There did not seem to be any reason why the consideration of a problem of this kind should be limited by arbitrary town boundaries. The limit of electrification should depend mainly on traffic considerations, not on town lines. Hence the lines proposed to be electrified by the expenditure of $40,000,000 did not include all those 21 branches, but only some 14 or 15 of them.

Now, the first fact brought out by the reports of the companies was this great cost of $40,000,000 for the electrification of only a part of the lines within the district, and for passenger traffic alone. That would not, of course, remove the smoke nuisance, which would perhaps arise more from the freight than from the passenger traffic. The second fact developed was the statement from the roads that so far as experience showed on the New York end of their lines, the introduction of electricity did not effect any resultant economy. That is, the cost of electric operation was greater than the cost of steam operation, independent of the interest on the capital. Now, of course, nobody can reason about this theoretically and arrive at any reliable result. I do not suppose that even an electrical engineer would venture to do it; and still less should a lawyer or a civil engineer or a layman. It is the result of the experience of roads which have electrified the ends of their lines that the cost of operation is greater than it was before. The companies tell us—both of them—that to electrify the lines entering Boston would not be economical independent of the interest on the large expenditure involved. Notwithstanding this, I presume a good many people think the railroads ought to be obliged to go to such an expense, because it is for the convenience of the public.

The third consideration which the Board had in mind and which it considered was very important to take account of, was the broad economical question as to the effect of this electrification on rates. Of course, if the introduction of electric traction were to increase enormously the traffic, it might prove economical in the end. The Long Island Railroad of New York is a very different problem from the one presented in

for a simple engine and outside steam pipes extending from the front end to the high pressure cylinder. This same arrangement was followed on the Delaware & Hudson engine, although no superheater was there employed, because of it being inadvisable to use outside steam pipes from the dome on so large a boiler. The pipes in this case are 6 in. inside diameter wrought iron pipes and are arranged with a slip joint at the elbow connecting into the high pressure steam chest. They are, of course, very heavily lagged and carefully supported to the boiler shell. A

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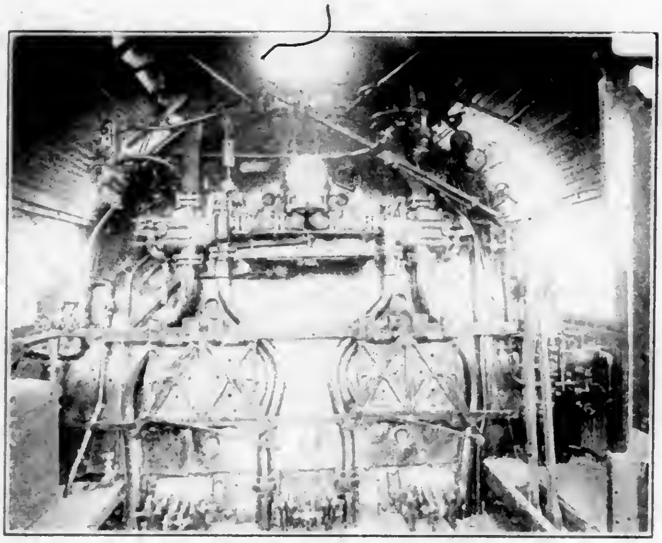
Tubes, length	20 ft. 10 in.	24 ft.	20
Tubes, heating surface	5,380	5205.5	3¼*
Total heating surface	5,600	5,526.9	1⅓*
Equivalent heating surface	5,600	7,029.9	25
Grate area	72.2	99.9	38.3
Wheel base, driving	30 ft. 8 in.	40 ft. 8 in.	33
Wheel base, engine and tender	64 ft. 7 in.	77 ft. 2¾ in.	19
Tender, water capacity	7,000	9,500	35
Tender, coal capacity	16	16	....

* Decrease.

TABLE SHOWING PROGRESS IN LOCOMOTIVE DESIGN ON THE B. & O. R. R.

surge plate, with enlarged openings for the tubes to pass through, is located about 54 in. back of the front tube sheet.



INTERIOR OF CAB, NEW B. & O. MALLETS.

The feed water discharge, which enters through an internal pipe, is close to the front tube sheet.

These locomotives are in many ways similar to the ones on the Delaware & Hudson mentioned above. The tractive effort is the same in both cases, although the Baltimore & Ohio engine has 4 in. greater stroke, which is off-set by the drivers being 5 in. larger in diameter and the steam pressure 10 lbs. less.

One of these engines has been fitted experimentally with a Crawford stoker having three troughs.

The drawings and photographs show the details of construction and the general dimensions, weights, ratios, etc., are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	105,000 lbs.
Weight in working order	461,000 lbs.
Weight on drivers	461,000 lbs.
Weight of engine and tender in working order	642,500 lbs.
Wheel base, driving	40 ft. 8 in.
Wheel base, total	40 ft. 8 in.
Wheel base, engine and tender	77 ft. 2¾ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.4
Total weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ equivalent heating surface*	837.00
Total heating surface ÷ grate area	55.00
Firebox heating surface ÷ total heating surface, per cent	5.80
Weight on drivers ÷ total heating surface	83.20
Volume equivalent simple cylinders, cu. ft	29.7
Equivalent heating surface* ÷ vol. equiv. cylinders	237.00
Grate area ÷ vol. equiv. cylinders	3.36

CYLINDERS.

Kind	Mellin Compound
Diameter	26 and 41 in.
Stroke	32 in.

VALVES.

Kind, H. P.	Piston
Kind, L. P.	D. P. Slide
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance, H. P.	5/16 in.
Inside clearance, L. P.	⅛ in.
Lead	3/16 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10½ x 13 in.
Driving journals, others, diameter and length	10 x 13 in.

BOILER.

Style	Conical
Working pressure	210 lbs.
Outside diameter of first ring	90 in.
Firebox, length and width	126 3/16 x 114 in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-5", B-4", S-4½ in.
Tubes, number and outside diameter	277—2¼ in.
Tubes, length	24 ft.
Superheater fire tubes, No. and diameter	38—5½ in.
Superheater steam tubes, No. and diameter	152—1⅜ in.
Heating surface, tubes	5,205.5 sq. ft.
Heating surface, firebox	321.4 sq. ft.
Heating surface, total	5,526.9 sq. ft.
Superheater heating surface	1,002 sq. ft.
Grate area	99.9 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 6 in.

TENDER.

Tank	Waterbottom
Frame	10 and 15 in. channels
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,500 gals.
Coal capacity	16 tons

* Equivalent heating surface equals total heating surface plus 1.5 times superheater heating surface.

A TRAVELING STOREHOUSE

The stores department of the Atchison, Topeka and Santa Fe Ry. at Topeka, Kansas, has recently inaugurated the traveling storehouse method for handling supplies. It if proves to be the success expected, it will be extended to points on the system other than the coast lines where it is now being tried out.

A new supply car, recently completed in the shop at Topeka, is to be started from a given point on the first day of every month. Shelves, pigeonholes and other receptacles are arranged in such a manner as to greatly facilitate the handling of small materials and stationery. For conveying larger and heavier material additional flat cars attached to the main supply car are used. On receipt of requisitions for repairs and renewals the storekeeper will assemble and load on the cars sufficient material for the main line covering track tools, frogs, switches, cattleguards, farm gates, fence wire, staples, spikes, bolts—in fact, all items for renewals aside from complete bridges or buildings. After loading has been completed the flat cars containing the heavier material will be coupled in ahead of the main supply car in a regular train. It will probably require six or eight cars to transport satisfactorily all the material required for a single trip.

At present it is the intention to cover the Albuquerque, Arizona and Los Angeles divisions only, and, if it is found possible to cover the entire coast lines once a month, arrangements for an extension of this new method will be made accordingly. The operation and development of this new way of collecting, transporting and delivering supplies will be watched with interest all along the line. On a previous trial with a temporary car on five divisions of the system it was found that a saving of over three thousand dollars a month was made on the various items carried at that time, and it is expected that, through the co-operation of other departments, when the details of the present trial are worked out, an even greater saving in time and money will have been accomplished.

ELECTRIFICATION IN BOSTON

Two years ago a very elaborate report was made by a commission which suggested a complete rearrangement of all railroad terminals in the city of Boston and involved the construction of a tunnel which rendered electric operation necessary. This report was referred to a joint commission, which last year submitted a preliminary report to the legislature, recommending that it request the railroads to make investigations and studies with reference to electrification. The legislature, however, amended the report by requiring the commission to present with its report a draft of a bill which should compel the electrification of all steam railroads in the metropolitan district within a stated time. The railroads made a report to the joint board last November and the commission had but two months in which to study the subject and present its report to the legislature. In this report, made last January, it advised against any compulsory legislation, but the opinion was not unanimous except in that particular.

At the March meeting of the New York Railroad Club, being the seventh annual electrical night, Professor George F. Swain, department of engineering, Harvard University, who was a member of this commission and a signer of the majority report, presented in a very clear manner the line of reasoning which led to the conclusions as reported by the majority. Mr. Swain spoke in part as follows:

The so-called metropolitan district comprises a number of cities and towns in the neighborhood, and is bounded simply by the boundaries of those towns and cities. It, therefore, comprises an irregular area around the State House in Boston extending from ten to fifteen miles and in a few instances perhaps twenty miles out. The average distance is only ten or fifteen miles from the center. There are three main systems of railroad entering Boston: The N. Y., N. H. & H. System enters from the south and southwest; the Boston & Albany from the west; and the Boston & Maine from the north and west. There are some twenty-one different branch lines of these three systems comprised within the so-called metropolitan district; and a compliance with the compulsory legislation suggested by the last legislature would have required the electrification of these twenty-one the whole or parts of various lines, some of which form loops, extending as I said from ten to fifteen miles from the center of the city.

Now, you will observe that that is an entirely different problem from that which exists in New York City. Here you have the New Haven and New York Central roads running almost north from the terminal station, with only three branches, whereas in Boston we have some twenty-one branches to consider.

Now, the reports from the railroad companies indicated the cost and the various elements which entered into the problem around Boston. We are all of us agreed, undoubtedly, that we would like electrification. The Boston public is no different from the New York public, or the Chicago public or the public of any other large city in that respect. The advantages are undeniable. The reduction of smoke; the increased distance which can be covered in a given time, owing to the quick acceleration of electric trains; and the increasing value of property in the vicinity of the roads owing to the noiseless operation, and the absence of smoke and dirt, are three great advantages to the public. There are also, of course, advantages to the railroad companies, and unquestionably economies can be effected. The saving of coal by electric operation is undeniable; the saving of repairs is undeniable; the saving in corrosion of overhead structures, due to escaping smoke and gases from locomotives is also undeniable. Then there are economies which may in some cases be effected by utilizing the space over tracks for building. Whereas no use can be made of the space over the tracks of a steam railroad, it is possible to utilize the space over electric stations for office buildings, or for buildings of many sorts, in large cities. But that, however, is a real estate problem. In some cases it may prove to be a source of economy, while in other cases it would not be, because no such investment of capital would be justified. Then the economies in the saving of switching by the use of multiple unit trains is undeniable. So that in electrification everybody admits that there are great advantages for the public, and for the railroad companies as well.

On the other hand, electrification is very expensive. The question is whether it is wise to attempt to secure by legislative compulsion a thing which we all want to have, independent of the question whether it can be secured with ultimate resultant economy to the public. As I said, the board in Boston concluded that it was not wise to recommend any compulsory legislation.

Now, I think that most people are fair-minded and if they have the facts clearly presented to them, that they will not be consciously unfair in arriving at their conclusions. But I think most of us, and indeed all of us, are apt to make mistakes in reasoning from facts, or to base our conclusions upon insufficient facts. I think among the public in general there is a great deal of misapprehension with reference to electrification. And I think we have too many people who believe, because they want a thing, that this is sufficient ground for demanding it, especially if they can make somebody else give it to them for nothing.

Now, as I have said, the conditions in Boston are very different from those in New York. There are some twenty one lines radiating from the center, extending out fifteen or twenty miles to the limit of the metropolitan district. The reports from the railroad companies indicated that the cost of electrifying the principal lines in the metropolitan district would be $40,000,000, for the passenger traffic alone—of course, for freight traffic there would be a considerable addition to that expense and unless electrification were applied to both the freight and passenger traffic its advantages to the public would be materially reduced. $40,000,000 is a very large sum of money for the State to require the railroads to expend. Furthermore, the expenditure of this large sum would only electrify these various lines for an average distance of twelve or fifteen miles out.

Now, in New York City with the expenditure of half that sum, or about $22,000,000, the N. Y. Central and New Haven Companies have electrified their lines twice as far, or for a distance of thirty or more miles out, embracing a large part of their suburban traffic.

It is very expensive to electrify the stub ends of a number of lines. I think that is where an unjust comparison is often made. Boston people come to New York and seeing what is done here, they say if the New York railroads are able to give that service, they don't see why the Boston lines ought not to be compelled to give it. Of course, the electrification of an entire railroad presents a very different problem from electrifying only twelve or fifteen miles on one end of a steam road. In the latter case not much saving is effected on the steam operation, while the cost of electric operation is added. The steam locomotives have to be disconnected ten or fifteen miles out, and the trains are hauled from that point in by electric locomotives. The expense of steam operation is not materially reduced, while the expense of electric operation within the electric zone is added. If an entire railroad or an entire locomotive division could be electrified resultant economies could perhaps be secured. This is a very different thing from electrifying the stub end of a road.

The metropolitan district includes among the 21 lines I have mentioned some which join main lines just within the limits of the metropolitan district, which were left out in the estimates. There did not seem to be any reason why the consideration of a problem of this kind should be limited by arbitrary town boundaries. The limit of electrification should depend mainly on traffic considerations, not on town lines. Hence the lines proposed to be electrified by the expenditure of $40,000,000 did not include all those 21 branches, but only some 14 or 15 of them.

Now, the first fact brought out by the reports of the companies was this great cost of $40,000,000 for the electrification of only a part of the lines within the district, and for passenger traffic alone. That would not, of course, remove the smoke nuisance, which would perhaps arise more from the freight than from the passenger traffic. The second fact developed was the statement from the roads that so far as experience showed on the New York end of their lines, the introduction of electricity did not effect any resultant economy. That is, the cost of electric operation was greater than the cost of steam operation, independent of the interest on the capital. Now, of course, nobody can reason about this theoretically and arrive at any reliable result. I do not suppose that even an electrical engineer would venture to do it; and still less should a lawyer or a civil engineer or a layman. It is the result of the experience of roads which have electrified the ends of their lines that the cost of operation is greater than it was before. The companies tell us—both of them—that to electrify the lines entering Boston would not be economical independent of the interest on the large expenditure involved. Notwithstanding this, I presume a good many people think the railroads ought to be obliged to go to such an expense, because it is for the convenience of the public.

The third consideration which the Board had in mind and which it considered was very important to take account of, was the broad economical question as to the effect of this electrification on rates. Of course, if the introduction of electric traction were to increase enormously the traffic, it might prove economical in the end. The Long Island Railroad of New York is a very different problem from the one presented in

Boston. The Long Island Road is not a freight handling road. It is a passenger suburban road, mainly; while the lines entering Boston are freight lines. The great freight lines from the northwest and the southwest which take all the freight to and from the metropolitan district of Boston are the ones to be electrified. You see, these are very different lines from those of the Long Island Railroad, which is a suburban passenger distributing road. This Long Island suburban passenger traffic was not specially studied by us, because we thought that was a very different proposition from that presented by the New York Central and New Haven lines.

If the State requires the railroad companies to expend a vast amount of money for an improvement of this kind it ought to guarantee a return on the investment. It cannot fairly expect a public service corporation, it seemed to us, to expend so large a sum unless it could see its way to doing it voluntarily; because the State could not practically guarantee a return on that investment. Of course, in order to get the return on this investment of $40,000,000, the proper place to put it would be on the suburban rates, because the suburban passenger traffic would be the traffic to reap the benefit of the proposed electrification. But to raise the suburban rates from Boston would be a hazardous thing to do, because of the very short distance, comparatively, that the electrification would extend, and the fact that the entire area is honeycombed with trolley street surface lines. You probably know that a great deal of money has been spent in Boston in building subways. These subways are being extended every year, and just now there is a proposition to expend between $5,000,000 and $10,000,000 in addition to that already authorized for the purpose of facilitating the bringing of the suburban traffic by the surface trolley lines to the shopping district or the center of the city for a single fare. On the Newton circuit line of the Boston & Albany, a loop line, which goes to about ten miles from the city, the passenger traffic has not materially increased, we are told, in the last ten years. The district has grown up, but while the traffic on the street car lines has increased, that of the steam railroad line has not increased.

Thus it is clear that if the passenger fares should be raised, not only would the people be dissatisfied, but a still larger traffic would tend to be diverted to the street car lines, and the steam railroads might not get the additional revenue they require to cover their additional expenditure. Should this be the result, they would have to gain the needed revenue from the long distance passenger traffic or the freight traffic. Of course, we all know that the railroads cannot get back from each class of traffic the cost of that particular traffic. The reason is that the cost of the different items of traffic cannot be determined. It is impossible to determine what it costs to haul a ton of any given commodity from one point to another—there are so many elements which enter into this cost. Fairly, however, if costs could be exactly ascertained, each class of traffic should pay its own cost. From this point of view, the cost of electrifying the lines in the metropolitan district should be charged in some form on the Boston business. Boston is talking a great deal to-day about its port. As a matter of fact, I believe Boston has a better port than New York, and indeed the best port on the Atlantic coast. It has deep water and a clear channel right out to sea, only a short distance. But of course, it is a railroad terminal and it is handicapped to some extent by the fact that freight from the West in going to Boston, instead of sliding down hill from Albany along the Hudson river, has to be hauled up over the Berkshire Hills, and in hauling it up over the hills, the trains have to be split in two, because a locomotive cannot haul more than half the load it could on the West Shore or N. Y. Central. Therefore, the expense is greater in getting western freight to Boston, than in getting it to New York. Now, anything which would have a tendency to add to that expense or to detract from Boston's advantages as a port should not be considered for a moment. I am giving you the opinion of the majority of the Board, of which I was a member. Anything which would increase the rates on freight traffic to Boston would certainly be detrimental to the growth of Boston as a port.

Then there was a still larger and broader point of view which suggested itself to us, and that had to do with the general problem of the regulation of the railroads. Personally I believe in proper government regulation of steam railroads and other public service corporations. We all know that the establishment of the Interstate Commerce Commission has resulted in abolishing evils which the railroads themselves are glad to have abolished and which many of them had tried to have abolished before that commission was created, but without success.

However much we may desire electrical operation, it certainly must be considered as yet, so far as the public is concerned, a luxury. It is a luxury which we would all like to have. The question is, can we afford to pay for it?—because the public has to pay for it in the end, no matter how it is supplied, whether voluntarily or by compulsion. Now, it did not seem to us that this was something that the government should compel the railroads to furnish. We thought it was going a little too far to require a luxury.

Furthermore, a still greater and larger point of view which suggested itself was the moral effect of the passage of compulsory legislation. If one state should begin to require electrification, probably other states would follow. New York and Boston are not alone in desiring to get rid of the smoke nuisance and have electrification. All the great cities in the country want the same thing. Now, it can easily be realized what the result would be if all the states, or many of them, shoud compel electrification of their steam railroads. The result would be the requiring of enormous sums of money, and in raising these sums capital would not be assured of a return. It might in some cases obtain a return after a time, and in some instances traffic might be quickly increased so as to insure a fair interest on the additional invesement; but it would not be insured from the beginning, and in some cases it would not be *insured* at all.

Now, as we all know, our railroads are required every year to expend large sums of money for many things, in order to keep pace with the growth of the country. They must expend these sums to provide new tracks, new yards, new roundhouses, new equipment and all the various things which go to make up a modern railroad. The business doubles every few years. We all know what happened in 1906-7 when many of the railroads were not prepared for the large increase in traffic. Capital has to be assured of attractive investment, and if the states require compulsory electrification, capital may be deterred from investing in railroads even for the expenditures which are necessary, because of the fear of additional and onerous legislative requirements.

Another thing which seemed to us to make unwise the enforcement by legislative enactment of this much desired improvement was the fact that electrical engineers are not yet agreed as to a standard of electrification. The N. Y., N. H. & Hartford and the Boston & Albany proposed to install in Boston the same systems they use in New York City—two different systems such as there are here. This would require, therefore, if the trains of one road are ever to run over the tracks of another the duplication of machinery and unnecessary expense. The state of the art is not yet in such a condition that compulsory measures should be taken, it seemed to us.

A fact illustrating the great changes which may be brought about in a short time in the relations of the different roads in and about Boston has been brought to our attention since our report was made; and that is that the N. Y., N. H. & H. Railroad has asked the State Legislature for permission to build a tunnel under the harbor connecting its tracks on the south with the Boston River Beach and Lynn Railroad on the north—a narrow gauge independent line—so that through trains may be run into Boston, from New York and Providence under the harbor, and out on the north over the line just mentioned and the Boston & Maine line, to Portland and the Provinces. Now, thirty years ago all these railroads were independent of each other. The Boston & Providence railroad was a line by itself. The eastern division of the Boston & Maine and many other lines which now make of that system, were independent. If anybody had prophesied at that time that he would live to see through trains running over the Boston & Providence, the Revere Beach, and the Eastern Railroad, he would probably have been considered an imbecile. Yet that is something which now seems very near and indeed within reach.

The future relations between the steam railroads are just as uncertain now as they were then. Perhaps it may not be true that such great changes will take place in the future as we have seen in the past. Still, we cannot venture to predict what the result will be. These branch lines out of Boston are so interlaced that nobody knows what the future will evolve. It, therefore, seems that we ought not to hasten electrification in advance of the standardization of electrical appliances. The ideal electrification would be such that the trains of any line could run over any other line.

Now, those are the main reasons, gentlemen, which led the board in Boston to conclude that it was best to allow the problem to work itself out. There are those who disagree with our conclusions, and we must always respect the opinions of those who differ from us, especially on questions of public economy and public welfare; for we are all seeking the public welfare—or ought to be—although we may differ as to the best means to secure that welfare.

The minority of our Board thought the majority report would tend to unduly discourage electrification, that it made the objections too strong. I think they failed to realize, perhaps, that our objections were to compulsory electrification and that we were not against electrification if the railroads should choose to indulge in it. They said our report would tend to prevent the introduction of any electrification in Boston. But since that report was made, the New Haven road has petitioned the Legislature for permission to build this tunnel under the harbor, which of course would require electric operation and that of

course would require the electrification of the road at both ends of the tunnel. I think the roads should begin in this way and after their experience had gone far enough they should extend the electrification as far as they can see their way clear, and perhaps it will be long before our lines are electrified for long enough distances to produce some real economy. We may within a short time if the railroad companies are left to themselves, and allowed to proceed in the economical way, see the New Haven lines electrified to Providence and perhaps all the way to New York. I think this would be better than requiring first the electrification of a lot of little stub ends. So, if the problem is left alone, it will take care of itself, and the revolution will be according to economic laws.

I have described to you the condition of things and the status of the question as it presented itself to us. The matter is still before the Legislature. I do not know what they will do. They may pass some compulsory legislation, but I sincerely hope that they will see that it is not in the real public interest to do so. I believe the majority of thoughtful and well informed people realize that it is not in the true interest of the public to place undue burdens upon the carriers, but that they should be allowed to work this problem out themselves.

A WELL EQUIPPED CLEARANCE CAR

A new clearance car has just been placed in service on the Pennsylvania Railroad Lines East of Pittsburgh and Erie. This car was designed in the office of the Engineer of Maintenance of Way and built at the company's Altoona shops and is being run over every division as rapidly as possible in order to secure correct measurements of the distances from the track to projecting portions of station buildings, tunnels, bridges and other objects. It is also designed to indicate automatically while moving on curves the elevation of the rails and the degree of curvature.

The car, which is 54 feet 8¾ inches long over all, and 30 feet between truck centers, is built entirely of steel, and is equipped with air brakes, steam fittings and electric lights. The main floor is 4 feet 5¼ inches above the top of the rail and at the front end of the car where the templets are located is a second floor at an elevation of 9 feet 8 inches above the top of the rail. Both floors are for use in taking measurements from the templets. The second floor is reached by steel stairways on each side of the main templet. All measurements are taken at the center of the car truck, from which clearances are computed. The main templet, which is erected directly over the center of the truck, has a width of 10 feet between elevations at 2 feet and 12 feet above top of rail, exclusive of the fingers or feelers attached to the sides. From an elevation of 12 feet above top of rail, the templet recedes towards the middle of the car at an angle of 45 degrees, reducing the width of the templet to 4 feet at the top, at an elevation of 15 feet above top of rail.

Immediately in front of the main templet is constructed an auxiliary templet, designed to measure overhead bridges, tunnels and other objects between elevations 17 feet and 20 feet above top of rail. This auxiliary templet has the same dimensions as that part of the main templet between elevations 12 feet and 15 feet. It is supported on a center shaft enclosed in an upright cylinder and is capable of being raised to a height of 18 feet by a crank and ratchet arrangement on the floor of the car. Enclosed in steel cylindrical boxes with translucent glass fronts facing the templets is a series of electric lights which extend from the floor of the car on each side thereof to a height of 15 feet above top of rail. The well diffused light thus obtained makes it possible to take measurements both day and night, as well as in dark tunnels.

The fingers or feelers attached to the sides and the top of the templets are two feet long and are spaced six inches apart. They are hinged to the templets and held in the different positions by friction. Attached to the feelers and the side of the templet are graduated scales which indicate automatically the distance from the rim of the templet to a side or overhead object. In addition, a small board equipped with a set of feelers spaced one inch apart has been provided to measure cornices of roofs of shelter sheds, or other irregular objects close to the track. This board is detachable and can be fastened to the side of the templet at any point desired. As the car passes over a curve, an attachment on the rear truck indicates the degree of curvature on a scale inside of a cabinet which has been erected in the middle of the car. In this cabinet is also an instrument consisting of a long pendulum suspended vertically which indicates automatically the elevation of one rail of the track over the other. The side of this cabinet facing the main templet has been provided with a plate glass window, which enables the operator of the car to read the degree of curvature, or the elevation of the rail at any time.

With all of the attachments working automatically, it is possible to take clearance measurements while the car is running

CLEARANCE CAR OF THE PENNSYLVANIA R. R.

at a speed of four miles per hour; this is necessary at times in order to keep out of the way of regular trains. Though two men can operate the new clearance car, one taking the readings of the scales and the other recording them, where clearances are close and irregular it requires the services of three men.

THE CASE FOR THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY in its appeal to the commonwealth for additional aid may be briefly and simply stated. It receives from every student a tuition fee of $250 a year; it expends $470 a year upon the education of each student. The school receives from the State of Massachusetts at the present time $25,000 a year toward the maintenance. It is the recipient also of interest upon certain endowment funds. But it would still show an annual deficit were it not for voluntary contributions from its alumni and friends. An agreed sum annually from the former has helped the school to tide over financial stringency in the last few years. This agreement is about to expire by limitation. Over and above all this, the school is confronted with the necessity of moving into larger and better quarters. Eight hundred students from Massachusetts alone are enrolled. Figured at the per capita loss mentioned above, the net cost of these students to the school is $176,000 per annum. The president and corporation of the institute feel that it is not asking too much of the commonwealth to contribute less than two-thirds of this amount yearly in consideration of the benefits accruing to its citizenship.

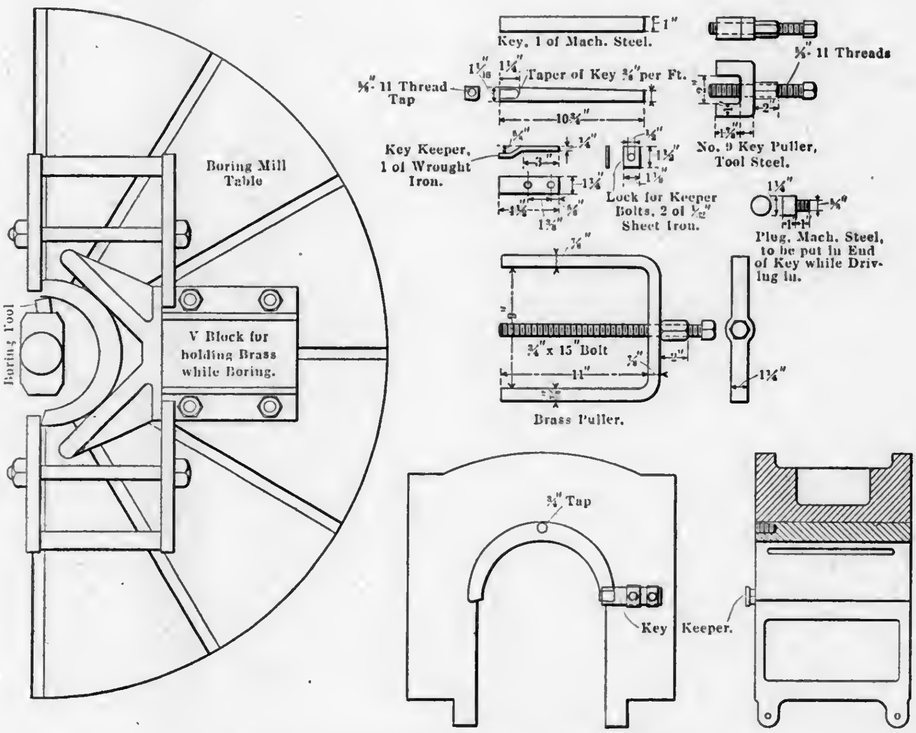
REMOVING DRIVING BOX BRASSED WITHOUT DROPPING THE WHEELS

CHICAGO & NORTHWESTERN RY.

A very successful method of removing worn driving box shells without resorting to the usual drop pit operation as a preliminary has been developed in the Clinton shop of the Chicago and Northwestern Railway, and is being extended to other points on that system. Through the use of the appliances illustrated the entire process, including the renewal of the brass, can be performed in from four to five hours, and at a cost for labor of not more than four dollars.

The cellar is first removed from the box having the brass to be removed and blocking placed between the binder and each leg of the box. The engine is then jacked until the brass is about one inch off the journal. If the former is loose in the box a ¾ in. hole is drilled and tapped in the end and it is removed by the brass puller, shown in detail in the accompanying drawing. Should the brass be worn so thin in the crown that this plan is not permissible it is divided by a ripping tool and the two halves removed by hand.

The new brass is turned 1/64 in. less than the box fit and its left hand lug planed to fit that of the driving box. On the right hand side, instead of a fit on the lug, allowance is made for a long tapered key of machine steel. This key is flat on the bottom, but the top is planed ⅜ in. taper to the foot to correspond with that on the lug of the new brass. The key is made first and placed in the box, the ends being allowed to project 1½ in. A tin or sheet iron template is then fashioned to fit the opening in the box, and this form is transferred to the end of the brass for the planer hand to work to. If the work is properly done the key will drive 1⅜ in., which will produce 30 to 35 tons pressure on the brass fit. To bore the brass for journal fit, it is held central and parallel on the boring mill table by the jig as shown. The drawing is fully explanatory of the remaining details of the general operation.



DETAILS OF JIG FOR REMOVING DRIVING BOX BRASSES.

THE INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION will hold its next convention in Chicago, July 25-27, 1911, instead of in May.

A PRACTICAL RUST PROOFING PROCESS

The prevention of rust in metals has not by any means been the least of the problems which the engineering profession in the past has been called upon to solve, but heretofore the efforts toward that end has been discouraging in view of the generally unsatisfactory nature of the results which have been attained. It was not until a quite recent date, when the "Bontempi" process was given publicity by the Eastern Rust Proofing Co., of Long Island City, New York, that it became apparent a solution is now at hand, and that it is possible to cheaply treat any metal in a manner to render it impervious to this destructive agent.

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When removed from the muffle the specimens treated are of a silver gray color when cooling. An oil bath gives a dead black surface which under the buffing wheel can be made to take a finish like polished gun metal. Articles thus treated will take paint and nickel-plating. A particularly appealing feature in connection with the process in general is that complicated devices can be treated without being dismembered. The penetrating power of the treatment is such that in a layer of small articles one foot deep, or even more, all of the articles receive exactly the same treatment. The size or amount of iron to be treated at one time depends entirely upon the size of the muffle.

Among the exhibits of the company, illustrating the durability of the process, are locks, all interior working parts of which have been rust-proofed in position, and screws and threads on pipes, treated in place, show no filling of the threads, the screws turning after treatment as easily as when first cut. A valve

which had withstood a pressure of 300 lbs. to the square inch was rust-proofed in all its interior parts, without being taken apart, showing that the fumes will go wherever air or gas can penetrate. Numerous other samples are on exhibition, the larger portion of which were treated over two years ago, and some of these have been constantly in the open, subject to the action of the elements and salt sea air, without the slightest sign of oxidization.

NEW CONCAVE BLADE COLD METAL SAW

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The machine consists of a very heavy cylindrical barrel, about 28 in. diameter in its bearings, on the periphery of which is located a bronze worm ring having teeth of steep lead, 37¼ in. outside diameter. The driving worm is of hardened steel fitted with roller thrust bearings, and the opposed stresses due to the drive are absorbed by the saddle in which the driving hub and worm wheel have a common bearing. The saddle is of exceptionally heavy construction, made with the base and cap securely bolted together, and having ample provision for oiling. It is fitted with square lock gibbed bearings on the base with adjusting screws to compensate for wear. The feed is obtained by a gear box giving nine changes of feed, and there is also available reversing fast power traverse. The feed screw is of very large diameter and has a bearing at each end to permit of its being maintained in alignment. The machine is driven by a General Electric, 20 h.p. motor.

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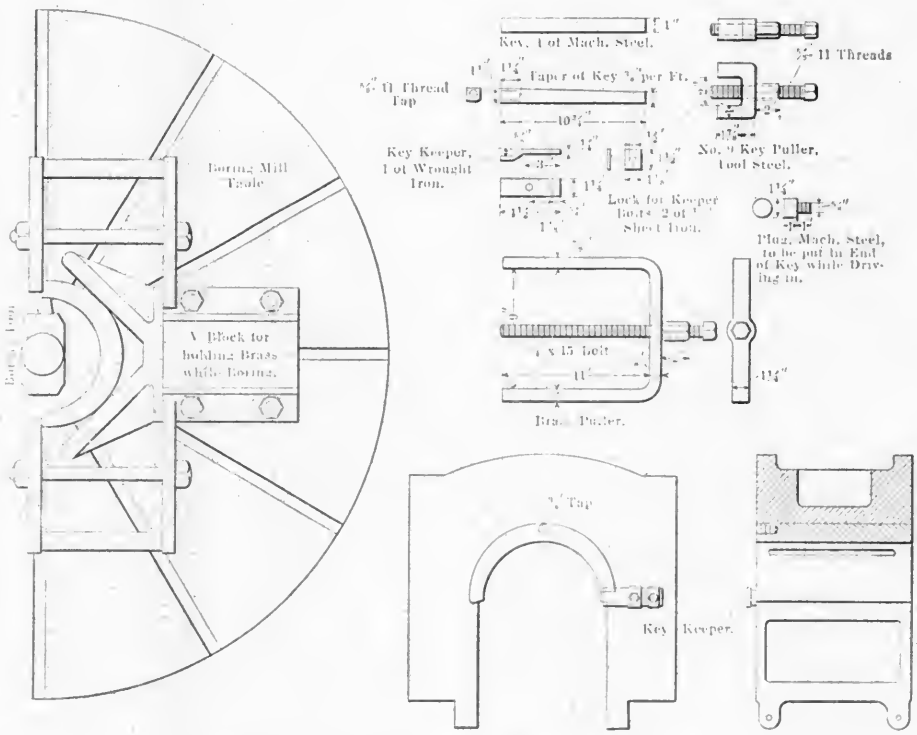
REMOVING DRIVING BOX BRASSED WITHOUT DROPPING THE WHEELS

CHICAGO & NORTHWESTERN RY.

A very successful method of removing worn driving box shells without resorting to the usual drop pit operation as a preliminary has been developed in the Clinton shop of the Chicago and Northwestern Railway, and is being extended to other points on that system. Through the use of the appliances illustrated the entire process, including the renewal of the brass, can be performed in from four to five hours, and at a cost for labor of not more than four dollars.

The cellar is first removed from the box having the brass to be removed and blocking placed between the binder and each leg of the box. The engine is then jacked until the brass is about one inch off the journal. If the former is loose in the box a ⅝ in. hole is drilled and tapped in the end and it is removed by the brass puller, shown in detail in the accompanying drawing. Should the brass be worn so thin in the crown that this plan is not permissible it is divided by a ripping tool and the two halves removed by hand.

The new brass is turned 1/64 in. less than the box fit and its left hand lug planed to fit that of the driving box. On the right hand side, instead of a fit on the lug, allowance is made for a long tapered key of machine steel. This key is flat on the bottom, but the top is planed ⅛ in. taper to the foot to correspond with that on the lug of the new brass. The key is made first and placed in the box, the ends being allowed to project 1½ in. A tin or sheet iron template is then fashioned to fit the opening in the box, and this form is transferred to the end of the brass for the planer hand to work to. If the work is properly done the key will drive 1⅛ in., which will produce 30 to 35 tons pressure on the brass fit. To bore the brass for journal fit, it is held central and parallel on the boring mill table by the jig as shown. The drawing is fully explanatory of the remaining details of the general operation.



DETAILS OF JIG FOR REMOVING DRIVING BOX BRASSES.

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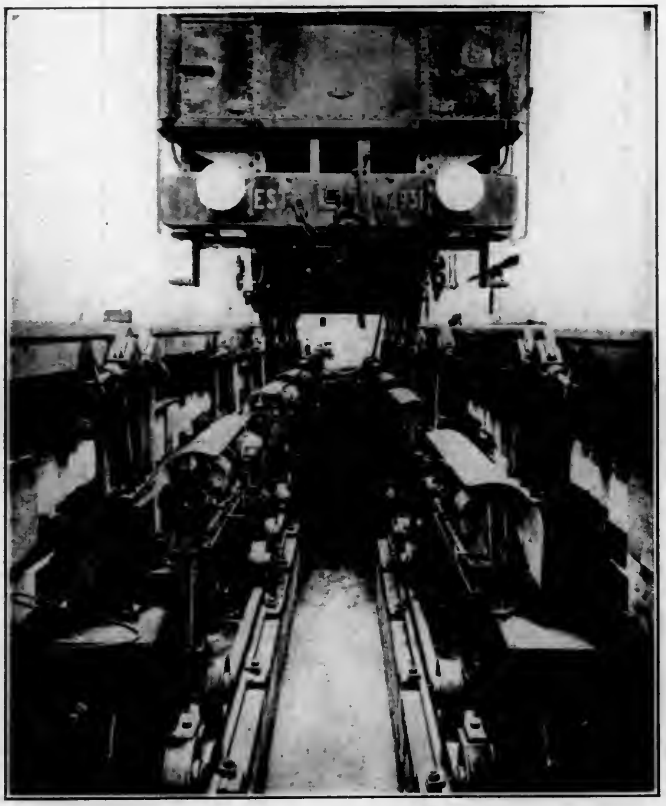

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As will be noticed in the photograph, the installation comprises a certain number of movable weighing apparatus, all alike, and mounted on carriages, so as to lie along the pit in two ranges. Each of the apparatus is designed so that the upper part can be raised under the locomotive wheel and bear up against the rim so as to lift the wheel off the track, thus raising the locomotive as a whole by means of each wheel. The mechanism which actuates the lifters is all operated by a common shaft passing along the side of each range. The two shafts are connected at the ends by gear and chain drive so as to be both worked together, and all the lifting is thus done from the end of the pit and at the same time. Thus the locomotive is raised quite equally and without oscillations. The movement can be carried out by hand through a ratchet lever, or by motor drive, preferably an electric motor. As to the scales proper, they are enclosed in a stout cast iron box mounted on four rollers so as to form a carriage, and running on rails laid along the floor of the pit. The scales work on the common steelyard or balance principle, so that they are of simple construction and easily standardized. Owing to the very limited space which was available for lodging the different parts of the lever mechanism, quite a special design had to be used for the levers.

The lifter, which receives the weight of the locomotive and brings the load in turn upon the levers, is made of suitable iron castings, and on the top is the wheel support, this being a cast iron base carying a pair of tempered steel rollers. The roller holders can be adjusted back and forth by screws, so as to adopt the rollers to take the rim of the locomotive wheel in the proper way. Ball bearings are used for the roller shafts, so that these can be readily turned even while taking a load of 12 tons per scale. All the divided scale beams lying on the outside and carrying their sliding weights are placed conveniently in line within the pit, and are easily handled for the weighing. The reading is done as usual by sliding the cylindrical weight along the scale beam.

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The side heads are carried in housings of entirely new construction, and each side head has a swinging chip breaker, swinging out of the way so that the head may be easily got at for adjustment. The side head housings are each moved by two screws, each pair being geared together and operated from the working side of the machine. The lower end of the mandrel runs in a step box which allows the end to rest in oil, thus insuring that it will positively run without heating.

REDESIGNED CAR SILL PLANER FOR WIDE RANGE OF HEAVY WORK.

The feed rolls, six in number, are of large diameter, with heavy journals, and powerfully driven by a train of large expansion gears. They raise and lower in massive housings by means of screws and a system of levers. All rolls are raised and lowered by power simultaneously, the operator standing at the feeding end and simply throwing in a lever. The feed has three changes of speed, varying from 30 ft. to 65 ft. per minute. It can be given faster or slower speed by changing the size of the pulleys. The whole length of the machine, including countershaft, is 17 ft., and the maximum width 5 ft. 4 in.

THE LARGEST STORAGE BATTERY PLANT.—A storage battery plant, said to be the largest single-battery plant of its kind in the world, will be erected by the Consolidated Gas, Electric Light and Power Company, of Baltimore, as soon as a building now being constructed for it is finished. The building will adjoin the largest direct-current sub-station of the company, and will cost about $50,000, while the entire cost of the plant will approximate $300,000. The storage battery will be of sufficient size to provide for the peak load in the entire business district for nearly half an hour should an accident occur at the time of maximum consumption.

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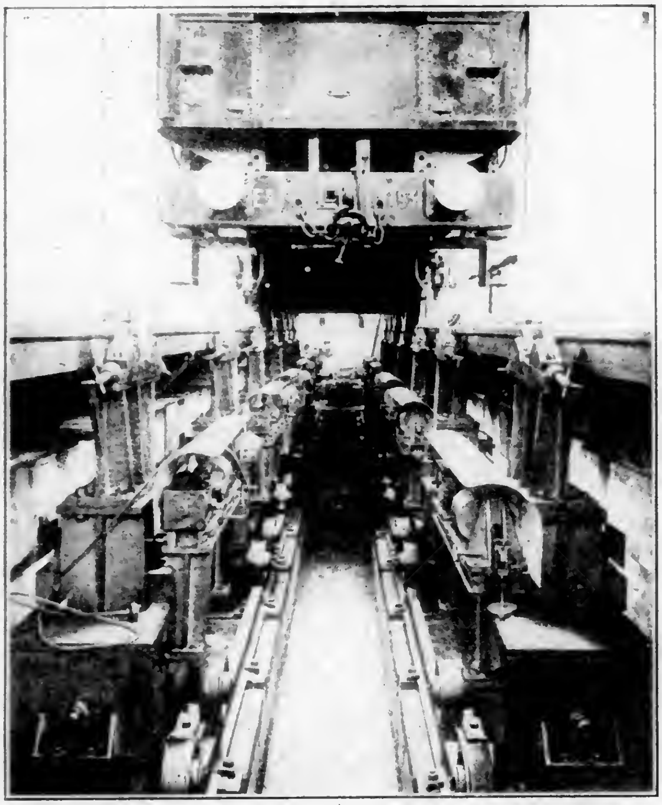

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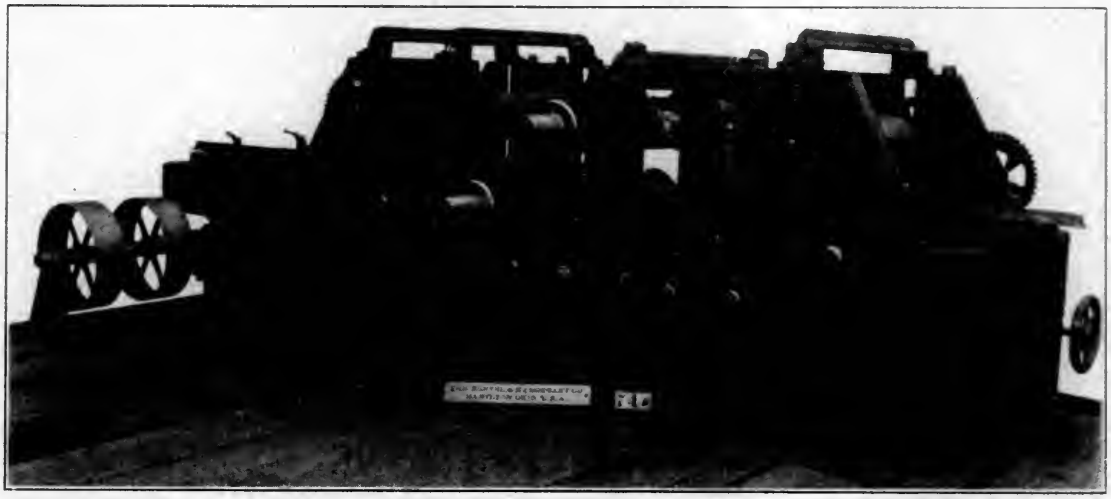
The side heads are carried in housings of entirely new construction, and each side head has a swinging chip breaker, swinging out of the way so that the head may be easily got at for adjustment. The side head housings are each moved by two screws, each pair being geared together and operated from the working side of the machine. The lower end of the mandrel runs in a step box which allows the end to rest in oil, thus insuring that it will positively run without heating.



REDESIGNED CAR SILL PLANER FOR WIDE RANGE OF HEAVY WORK

The feed rolls, six in number, are of large diameter, with heavy journals, and powerfully driven by a train of large expansion gears. They raise and lower in massive housings by means of screws and a system of levers. All rolls are raised and lowered by power simultaneously, the operator standing at the feeding end and simply throwing in a lever. The feed has three changes of speed, varying from 30 ft. to 65 ft. per minute. It can be given faster or slower speed by changing the size of the pulleys. The whole length of the machine, including countershaft, is 17 ft., and the maximum width 5 ft. 4 in.

THE LARGEST STORAGE BATTERY PLANT.—A storage battery plant, said to be the largest single-battery plant of its kind in the world, will be erected by the Consolidated Gas, Electric Light and Power Company, of Baltimore, as soon as a building now being constructed for it is finished. The building will adjoin the largest direct current sub-station of the company, and will cost about $50,000, while the entire cost of the plant will approximate $300,000. The storage battery will be of sufficient size to provide for the peak load in the entire business district for nearly half an hour should an accident occur at the time of maximum consumption.

TESTS OF FREIGHT CAR TRUCKS

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A special piece of track was constructed for the purpose of these experiments, consisting of a sharp incline having a drop of about 36 ft., which was followed by a short tangent of 30 ft., then a 22 deg. curve 303.3 ft. in length, the outer rail being raised 4½ in., followed by a tangent of 257 ft. and ending in an incline having a vertical rise of 20 ft. The gauge was 4 ft. 8½ in. on the tangents and 4 ft. 9 in. on the curve. The curve had a rise of 3 ft. 10¾ in. in this length, and the tangent following it had a total rise of 11.73 in. From the foot of the starting incline there was also a straight piece of level track 600 ft. in length at the end of which there was an incline of about 25 ft. rise.

The tests were conducted upon the different types of freight car trucks and different modifications of the same type of truck, which had been taken from under cars in regular service. There were 24 trucks tested. The brake shoes and brake beams were removed to eliminate any friction that might result from the contact of the shoe with the wheel.

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In obtaining the resistance in pounds per ton the following formulæ was used:

$$K = \frac{V^2 W}{2g} + \frac{\left(V\frac{G}{R}\right)^2 W_1}{2g}$$

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- K = Kinetic energy at another point of track.
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- D = Length of track in feet for which the loss in kinetic energy was obtained.
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$$t = \pi \sqrt{\frac{G_1}{g s}}$$

$$G^2 = G_1^2 - s^2 = \sqrt{\frac{t^2 g s}{\pi^2}} - s^2$$

In which
- t = Time of a single oscillation.
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The radius of gyration as obtained for a pair of 700 lb. 33-in. cast-iron wheels and their axle was .573 ft., and for a pair of 33-in. Davis cast-steel wheels and axle was .559 ft.

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METHOD OF HOLDING ARCH BAR TRUCKS SQUARE.

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DETERMINING MOVEMENT OF SIDE FRAMES.

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I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1	A	1 and 2	33.84	26.80	23.07	18.27	246,442	154,556	91,886	302.95	48.39	22.69	None
2	A	1 and 2	34.33	24.92	23.40	16.99	251,268	132,384	118,884	391.93	63.21	37.51	3.78
3	A	1 and 2	27.83	15.66	18.97	10.68	165,115	52,280	112,835	372.00	60.00	34.30	3.78
4	A	1 and 2	27.87	18.55	19.00	12.64	167,137	74,039	93,098	306.95	49.03	23.33	None
5	A	1 and 2	24.69	13.74	16.83	9.37	131,533	40,613	90,920	297.69	47.65	21.85	None
6	A	1 and 2	24.53	9.32	16.73	6.34	128,280	18,516	109,762	361.69	58.36	32.66	3.78
7	A	1 and 2	22.98	11.01	15.67	7.50	113,532	26,087	87,475	288.31	46.05	20.35	None
8	A	1 and 2	22.98	4.17	15.67	2.84	112,476	3,701	108,775	358.63	57.84	32.14	3.76
9	B	1 and 2	23.80	11.84	16.25	8.08	213,254	52,773	160,481	529.11	46.25	20.85	None
10	B	1 and 2	23.66	5.30	16.15	3.62	210,786	10,572	200,214	660.11	57.70	32.00	3.78
11	B	1 and 2	25.51	10.80	17.42	7.37	245,001	43,906	201,093	663.01	57.95	32.25	3.78
12	B	1 and 2	25.31	14.74	17.25	10.05	241,183	81,796	158,388	525.51	45.95	20.23	None
13	B	1 and 2	28.44	19.39	19.39	13.22	312,656	141,654	171,002	563.80	49.28	23.58	None
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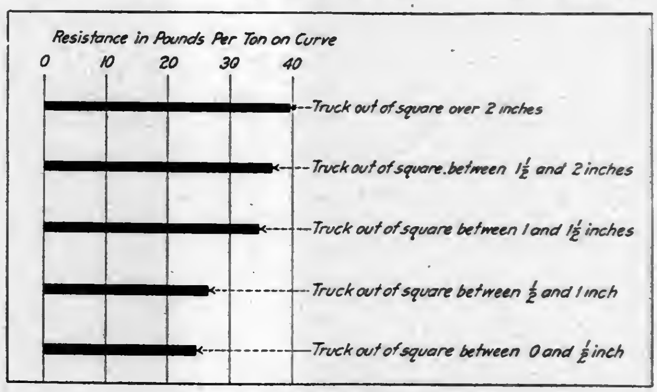
All of the values of the tests obtained for trucks that went out of square less than ½ in. were averaged and a resistance of 24.68 lbs. per ton obtained. Also the result for all tests of loose trucks were averaged and a resistance of 38.33 lbs. per ton was obtained. These two average resistances for square and loose trucks have been plotted, together with the average resistance on the short tangent, which resistance amounted to 6.38 lbs. per ton. With the tangent resistance as an origin, a straight line was drawn between the tangent resistance and the two curved resistances as shown, the upper line representing results for loose trucks or those getting out of square 1½ in.



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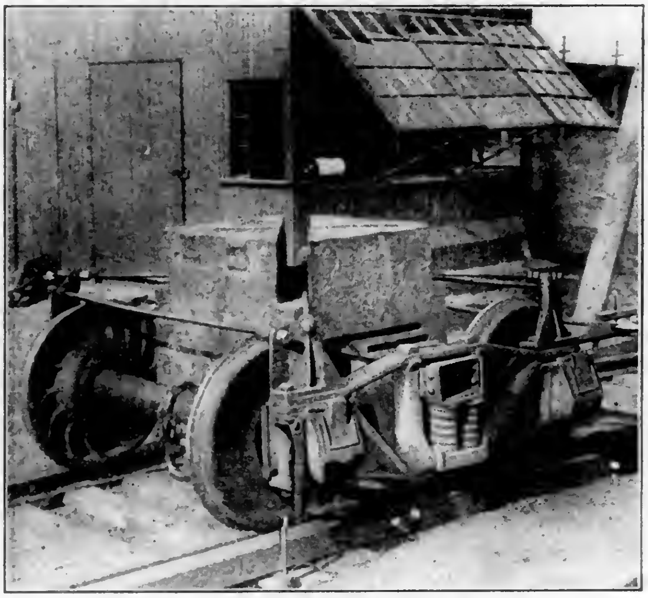

METHOD OF HOLDING ARCH BAR TRUCKS SQUARE.

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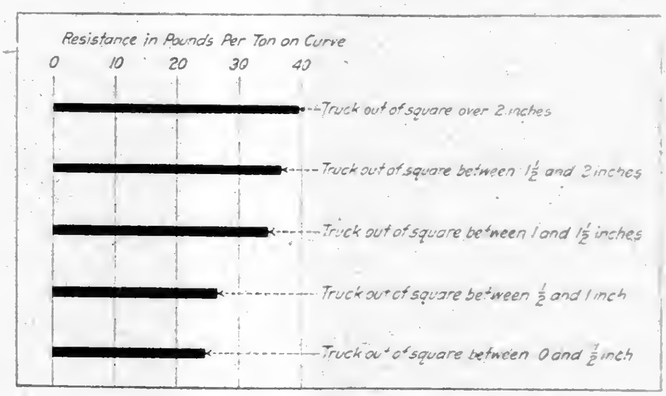

TABLE OF TRUCK RESISTANCE.

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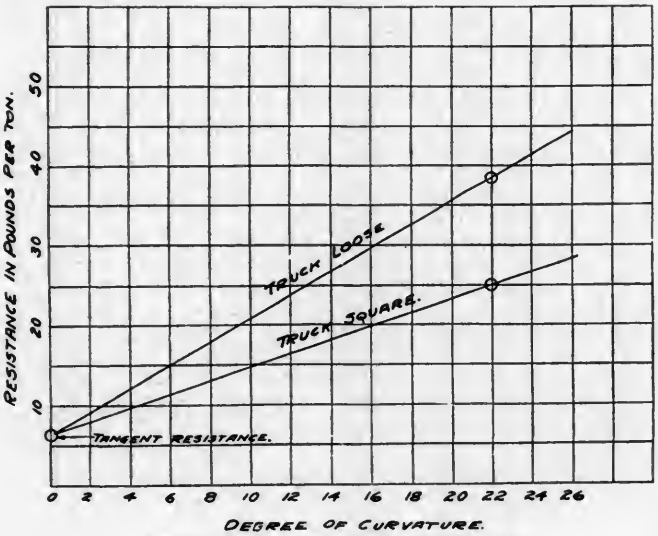
or more, and the lower line representing the square truck or those getting out of square ½ in. or less. These two lines were drawn straight because it is generally accepted that the resisance due to curves is in direct proportion to the degree of curvature. From these two lines it was computed that the per cent. of saving in favor of the truck squared varies from 7.9 per cent. on a 1 deg. curve to 36.5 per cent. on a 26 deg.



RESISTANCE FOR DEGREES OF CURVATURE.

curve, and taking 4 deg. as the average main line curve, the saving is 20.3 per cent. in favor of the truck squared.

On the 600 ft. straight track tests were also made with non-mated wheels on the same axle (Trucks A_1 and A_2). The results are given in Table II. It will be seen that the resistance under these conditions is very decidedly affected by the condition of the frame, i. e., loose or square. In Truck A_1 the wheels taped under or over the standard as follows: Wheel No. 1, 13/16 in. under; No. 2 on same axle, 3/16 in. under; No. 3, ⅛ in. over; No. 4, 5/16 in. over. On truck A_2, No. 1 and 2 wheels were the same as above, but No. 3 taped ¾ in. under, and No. 4, 3/16 in. under.

From these tests it would seem that where the wheels of the

Truck	Date	Average Temp.	Initial Speed Miles per Hour	Number Runs of Truck		Average Distance Truck Traveled		Number of Feet in Favor of Square Truck	Per Cent Favor of Square Truck
				Loose	Square	Loose	Square		
I	II	III	IV	V	VI	VII	VIII	IX	X
A	10-29-'10	44°	23.07	15	12	4288	4315	27	.62
A	11- 2-'10	47°	23.62	12	12	4398	4406	8	.18
A	11- 3-'10	41°	22.41	15	13	3935	3966	31	.78
A_1	11- 5-'10	47°	24.46	20	20	3928	3957	29	.74
A_2	11- 7-'10	67°	24.22	12	11	4888	4920	32	.65
A_2	11- 9-'10	70°	23.63	6	6	5097	5254	157	3.07
					Aver.	4422	4469	47	1.06

TABLE II.

truck are not well mated, a method of construction which will hold the axle perpendicular to the track will tend to slightly reduce the resistance.

The tests so far conducted have suggested several interesting things, which could not be developed owing to the lateness of the time in the fall, so it has been decided to continue the tests next summer, at which time it is hoped that sufficient data will be obtained to clearly demonstrate several interesting as well as important matters. To this end three additional pieces of experimental track are being constructed, having a curvature of 3, 6 and 12 deg. respectively. After tests are run on these three curves, there will then be available data as obtained from four different degrees of curvature, whereby a more satisfactory comparison can be made between the resistance of square trucks and loose trucks on different degrees of curvature.

The complete report on the tests have been published in a very attractive illustrated booklet by the American Steel Foundries.

A WELL DEVELOPED TURRET LATHE

In the design of the handsome tool shown in the accompanying illustration the Indianapolis Machine Tool Co., of Indianapolis, Ind., has worked out a machine embodying many unusual features of sterling merit, and one which at the same time maintains an entire exemption from criticism. It is noticeable in the photograph that the lathe is adapted for heavy chucking and bar work, and the combination of strength and rigidity so plainly apparent insures its capability for rapid and accurate duplications. That it is heavy enough from a general standpoint to take care of the most severe strains without injury is prominent, and the convenient arrangement of the controlling and operating levers is particularly pleasing.

A study of the details of this interesting machine will afford a good indication of the progress made in the development of turret lathes, and will forcibly attest to the ingenuity of machine tool designers in so effectually eradicating the points of weakness which were so prominent in the years following the introduction of this useful appliance. In this instance it will be noted that the bed and headstock housing are one casting. The former has heavy flat ways, and in addition to a lateral rib through the center has cross ribs every 13 inches. The construction, so far as this particular feature is concerned, effectually eliminates any possibility of deflection in the bed and at the same time insures the strength which is necessary to withstand the varying stresses to which machines of the turret type are subject.

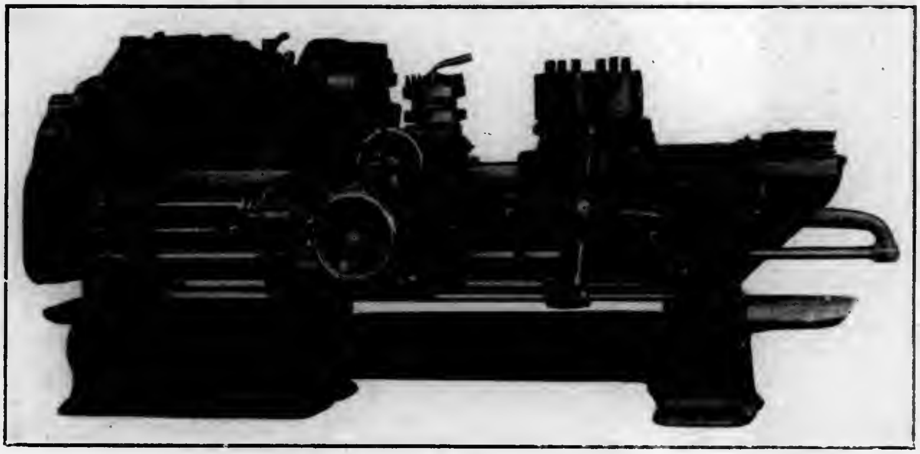
The drive is either by belt from one or two speed countershaft or by motor, either 5 or 7½ h.p. In the case of belt drive it is from a 4 in. belt to a 16 in. pulley, which drives the high speed shaft 480 r.p.m. with a one speed countershaft. If one of two speeds is desired, the high speed shaft on the second speed would be 384 r.p.m. The single belt drive mechanism is separate from the headstock proper, and is fitted into a housing cast solid with the bed and headstock, so that the whole mechanism may be removed in case of repair or adjustment. This mechanism is composed of two friction gear drives, the latter being to the intermediate shaft, giving two speeds forward, which, with the four mechanical changes in the headstock, gives eight speeds forward.

There are two double friction clutches in the headstock, one a band friction in the driving mechanism, and the other a cone friction on the intermediate shaft. Those in the driving mechanism are on a shaft which runs 480 r.p.m., and those on the intermediate shaft are on a shaft which never runs less than 240 r.p.m. In both instances the locking mechanism is such that it gives all the effect of a positive clutch without the disadvantages. The wearing parts of the friction dogs are of tool steel properly hardened, and through these frictions the operator is always in absolute control of the spindle and chuck. The main spindle is of 40 to 50 point carbon steel, with 3⅛ in. hole. Its bearings are of bronze of ample proportions, adjustable for wear, and provided with ring oilers.

The turret embodies several ingenious and novel features. It is of the hollow hexagon type, 12 in. in diameter, with six holes bushed to 3¼ in. One lever operates both the lock pin and clamp, and six automatic stops are provided, one for each face of the turret, the latter being drilled to receive the various

tools. One revolution of the pilot wheel moves the turret one inch, thus giving the operator an immense leverage in coming up against a heavy cut. A sight indicator is also provided to advise the operator of the depth of the cut should he desire to use it after the automatic stops have operated.

Power rapid traverse is provided for each carriage. This mechanism operates instantly at the rate of 40 ft. per minute, and stops immediately when thrown off. The traverse for each carriage is entirely independent of the other, and can be operated either way, regardless of what the other carriage is doing or whether the feel is on or off. In operating the power rapid traverse none of the headstock gears or feed gears are used, so that neither the pilot wheel on the turret slide nor the hand wheel on the tool post carriage turn or move in either direction when the rapid traverse is thrown in. This power rapid traverse mechanism is driven from the main driving shaft of the machine, and does not require separate countershaft or motor.



THE NEW INDIANAPOLIS TURRET LATHE.

The tool post is of the four-sided heavy turret type. It will carry four tools at one time, and each is independently adjustable for height. This tool post can be clamped in any desired position, or locked in any of eight different positions. It is of very rigid construction and has a double acting clamping device, both inside and outside, so that broad faced tools can be used to advantage. Both cross and lateral power feeds are provided, and it has a rapid traverse altogether independent which will operate either way, whether the feeds are on or off.

The tool post carriage is of the side carriage type, having a bearing on the front way 5⅞ in. by 24 in., with a long taper gib on the side of the front way. It is further gibbed to a 60 degree angle on the lower side of the bed to take care of the cross strain. In this side carriage construction the bearing, which on an ordinary engine lathe goes on the back way, is simply transferred to a bearing on the bottom of the side of the bed, thus getting the cross slide out of the way, and giving the full swing capacity to the lathe. This permits the tool post to pass the chuck and the turret to come up flush with the latter, doing away with the necessity of long overhanging tools

Minor parts of the machine have not been by any means neglected in the refinement which has been achieved in this design. Particular attention has been paid to lubrication, which is as complete as possible. The oil pans are cast iron and placed at such a height from the floor so as not to inconvenience the operator. All pans drain into the large pan in the center of the machine, which contains a strainer. From this the lubricant flows into the front leg of the lathe, which acts as a reservoir and from which the oil is pumped back to the work by means of a rotary pump, located on the back of the machine and driven from the rapid traverse shaft.

A Little Lard Oil rubbed on hardened and polished steelwork, which is to be drawn on a plate over an open-forge fire, will prevent the smoke from obscuring the tempering color.

HIGH EFFICIENCY IN SAND BLASTING AND PAINT SPRAY WORK.

The advantages of the sand blast for many classes of work have been accorded general recognition for quite a long period, but the adoption of such apparatus has not proceeded heretofore with the rapidity which might be looked for, largely on account of the excessive cost of the machinery necessary to do economical and efficient work.

The sand blast apparatus herein illustrated, which is a product of the Mott Sand Blast Mfg. Co., of Chicago, Ill., through the elimination of elaborate and useless parts, and other changes tending toward the utmost simplicity in design, effectually overcomes this latter objection, and represents the highest development which it has been possible to secure in this extremely valuable appliance. Its efficiency is just as great at the end of one or two hundred feet of hose, as at the end of a ten foot section, and it has a very great advantage in the fact that there are no devious and crooked pipes to clog. The air takes up the sand and carries it along in a straight line. The

MOTT PAINT SPRAYING MACHINE.

flow of sand can always be adjusted to the exact volume best adapted to the work at hand. As an illustration of the efficiency to which this machine has been raised it may be said in cleaning steel cars, one man and one machine clean an average of three cars a day, ready for the painters. This work by hand would require forty men, and the sand blast does a better job, the sand cleaning where hand tools cannot reach.

The same principle involved in the construction and operation of the Mott sand blast has been also successfully adopted by the company in the application of paint by the spraying process. An idea of the economy in time, labor and material may be gained from tests showing that an operator may easily spread 40 gallons of oil paint of 60 gallons of mineral paint in one day, under 20 or 35 pounds pressure, with a 25-foot length of hose. The flow of the paint can be regulated to suit the work; the paint being mixed automatically. The air that reduces the paint to a spray at the same time serves the purpose of maintaining it at uniform consistency in the tank. The sand and paint machines are practically the same in constructive details.

A NEW RADIUS PLANER ATTACHMENT

In machining motion links and obtaining the proper curve in the slot several requirements are absolutely necessary in connection with the device to be employed for the work, and these may be briefly enumerated as follows:

1st.—An absolute correct circle radius.

2nd.—A rigid construction permitting of heavy cuts to keep pace with up-to-date tool capacity.

3rd.—A wide range in adjusting the rigging to any radius occurring on motion links.

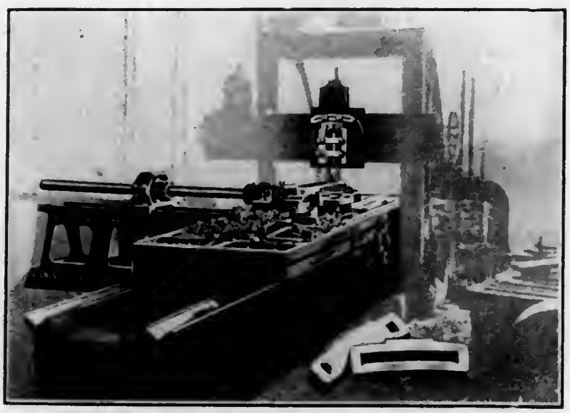
4th.—Absolute absence of wear on all parts that may impair the accuracy of the curve.

5th.—An easy adjustability to radii of any length and of changing and rechanging straight planer work with radius cutting.

6th.—A concentrated method of curve cutting in order to finish the whole operation in one setting.

A review of practically all of the various machines and methods which have been tried at different times with a view to obtaining something that would permit rapid, accurate work, and of such construction that wear would not interfere with its exactness has led to the design and construction by H. B. Underwood & Co., Philadelphia, Pa., of a new radius planing attachment which has many features of exceptional merit.

This radius attachment allows very heavy cuts and stands up to the limit of the machine tool without injury. After the link has been planed, milled around the edges, the end clearances drilled and slotted, it is set up on the chuck table and the center block removed by parting with two tools simultaneously. This parting operation, including setting up link and lifting out block after parting, has been done on a 15 h.p. planer in 35 minutes, the link of hammered steel 3½ inches deep. After parting, the slot is finished by side tools kept steadily in the other tool



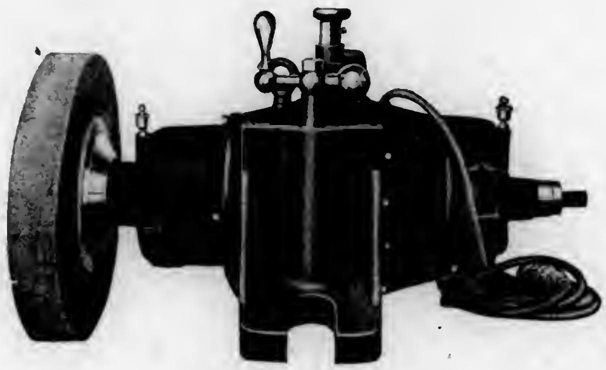
APPLICATION OF THE UNDERWOOD RADIUS ATTACHMENT.

heads of the planer. The advantage of this method consists in having one setting for blocking out and finishing both sides and in the absolute correctness of inside and outside radius.

A square block which is integral with the bottom plate; that is fixed to the planer table, transmits the driving power to the top plate always in the direction of the reciprocating movement without giving a resulting force with the tool resistance other than parallel to it. The oscillating component of the mechanism is allowed through an enlarged pin that surrounds the square block kept down by a cover plate. An enlarged eye engages around the pin and with a retaining ring forms on its top side the setting table. For setting up, the link is lined up to a center line marked on the chuck. Owing to the very small amount of stress, the radial bar is a tube, and being comparatively light, is easily handled. It permits of adjustment to radii of different lengths by means of a guide that is double pivoted in a post sliding on a foot plate perpendicular to the planer direction.

PORTABLE ELECTRIC DRIVEN GRINDER

Portable grinding machines in recent years have been accorded much favor by shop superintendents and master mechanics in view of the wide range of work in which their use is permissible, and which with the appliances formerly at hand



necessitated the removal of the part with the attendant loss of time and expense These tools have proved of exceptional value in the dressing of steel castings, which are now so generally embodied in locomotive construction, and treat with equal facility frames, wheel centers and other parts which may not require planing all over, but should still be "burred" or roughly finished.

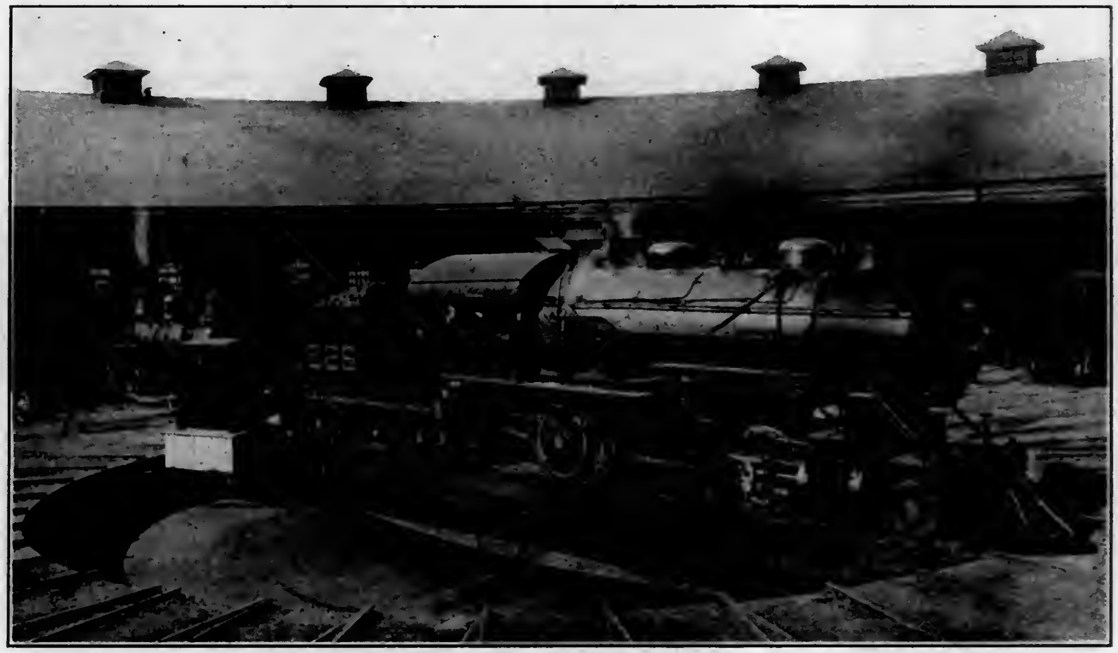
A remarkably compact and efficient example of portable electric grinder is that herein illustrated of 3 h.p., which is a recent output of the United States Electrical Tool Co. of Cincinnati, O. It is used to considerable advantage in in railroad shops on several jobs which without its assistance would be attended by greatly increased expense. One prominent instance of this utility advanced in its favor is the preliminary treatment of skid flat driving tires before turning. In many cases of this kind the spot becomes chilled so hard that the lathe tool rides or rounds it, and it becomes necessary to turn below the spot. Proper grinding over the latter obviates this difficulty and preserves much of the life of the tire.

NEW MAIN LINE BUILT IN 1910.—Official returns from nearly all the railways in the United States show that approximately 4,122 miles of new main railway line were built in the United States during the calendar year 1910, as compared with 3,748 miles during 1909. The 1909 record was over 500 miles more than for the preceding year, which was the smallest since 1897. New main track mileage is reported in 38 States and Territories, including Alaska, where 6 miles of new track were built. Texas, which was first in 1909, was first in 1910, with 756 miles. In Canada 1,844 miles were reported, as compared with 1,488 miles in 1909, an increase of 356 miles, and in Mexico only 138 miles were reported, as compared with 281 miles the previous year, a decrease of 143 miles.

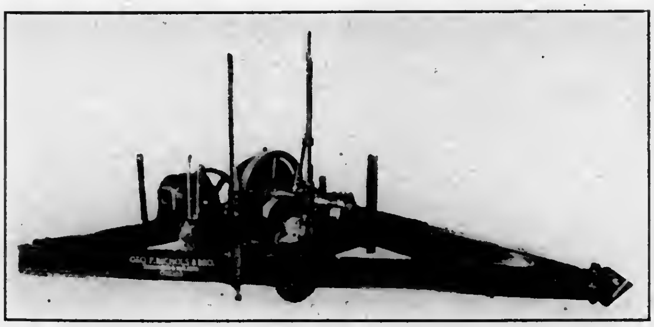
COMBINATION ELECTRIC TURNTABLE TRACTOR AND ENGINE HAUL

In many engine houses it is found necessary to handle dead locomotives over the turntable. This presents a difficult and expensive proposition, the only practical solution to which is, mounting some form of pulling device on the turntable itself. To meet this demand, Geo. P. Nichols & Bro., Old Colony Bldg., Chicago, have developed several types of engine haul, one of which is an independent device, and is usually mounted on the turntable girder near the center of the table. The control of this may be effected from the cab of an electric tractor, or from its own individual controlling stand. Occasions frequently present themselves, however, where a combined tractor and engine haul may be applied to the turntable in the same manner as a standard tractor.

The illustration shows such a tractor attached to a 66 ft. Nashville, Chattanooga & St. Louis Ry. turntable at Nashville, Tenn. This externally presents an appearance very similar to that of a Nichols standard tractor, the only apparent difference being that the machinery space housed in is a little larger and the cab is set somewhat higher than in the standard type. Within the machinery enclosure is the usual mechanism for the turntable drive, and also the entire winding mechanism, which consists practically of a winding drum driven through a friction clutch arrangement by the same motor which operates the turntable. By the use of friction clutches mechanically interlocked with each other, the motor may be connected with the table drive or with the winding drum at the will of the operator, but it is impossible to operate both mechanisms at the same time. The winding drum mechanism and clutch arrangement are the same as are usually employed on the Nichols transfer table, and the wire rope is led off from the drum around deflecting sheaves on the turntable proper, to snatch blocks at the ends of the table, in the same manner as in transfer table practice.



TURNING HEAVY LOCOMOTIVE WITHOUT TURNTABLE BALANCE.



TRACTOR REMOVED FROM TABLE.

A better idea may be obtained of the machinery arrangement by referring to the illustration which shows the tractor removed from the table and with the cab platform and machinery housing removed. A powerful brake is provided for the swinging mechanism, and also for checking or holding the winding drum. Above the machinery is mounted the operator's cab containing the steel switch box, the levers for the drum brake, travel brake, clutches and sand box. Current is brought to the turntable from beneath through the center casting, a swivel collector being mounted directly over the turntable center. As the turntable was an old one already in place, and the rounded top of the center casting was only 3¼ inches below the top of the rails, arranging a suitable collector presented some difficulties which, however, were very successfully overcome. As the table is very short, it is absolutely impossble to balance the newer and heavier engines which are now being turned, and the handling of locomotives prior to the installation of the tractor was exceedingly difficult and expensive. The tractor, however, is able to turn any of the engines on the table regardless of whether a proper balance is obtained or not.

Reference to the illustration shows that all of the wheels of the locomotive being turned are on one side of the center of the table, even when the locomotive is set as far back as possible. The engine haul pulls these engines on and off the table with case. Reports show that the cost of power for turning locomotives since the tractor was installed has been less than one-quarter of a cent each.

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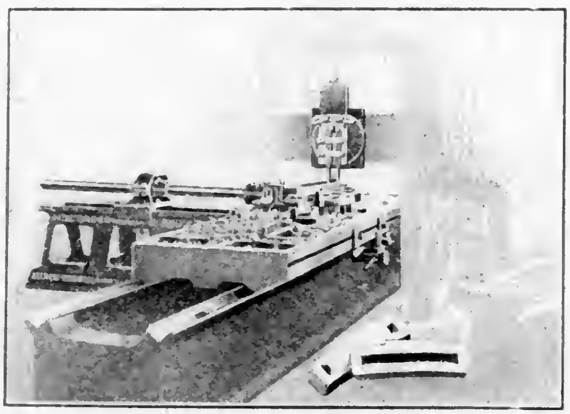

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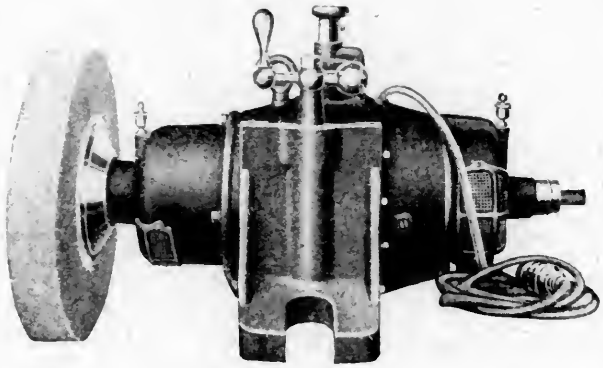

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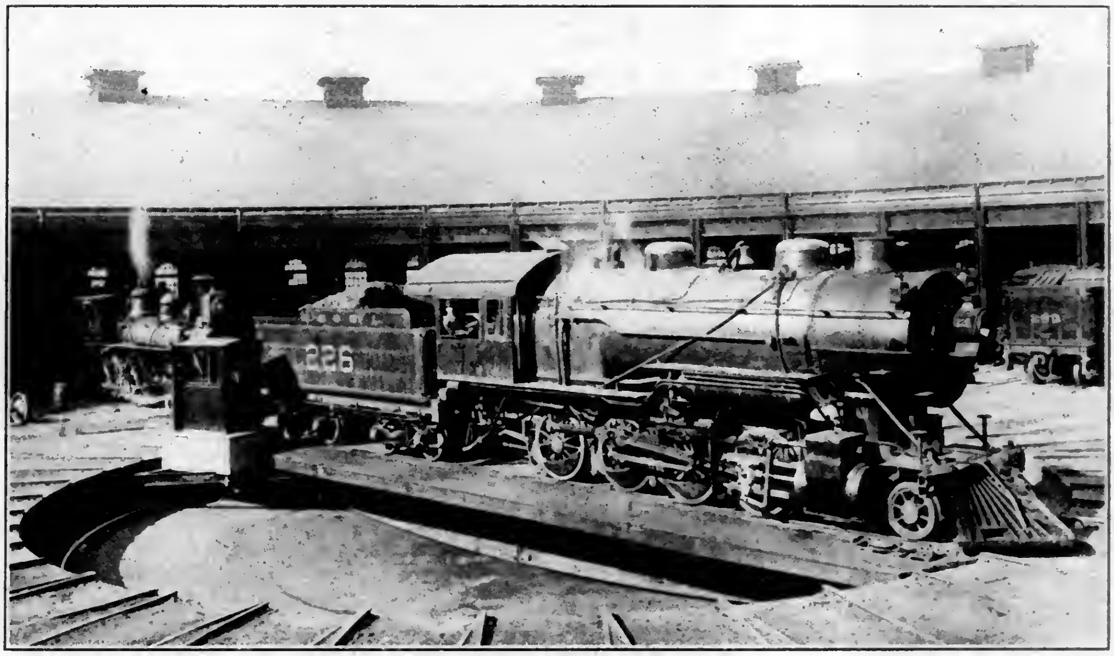

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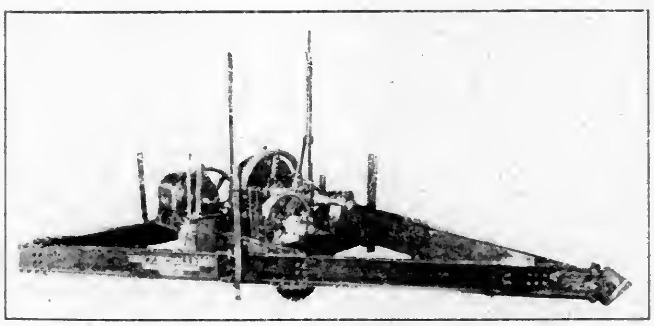

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The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	May 2	Annual Meeting and Smoker.		Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	May 12			H. D. Vought	95 Liberty St., New York
New England	May 9	Observations of Foreign Railways.	James F. Paige.	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	May 19	The Possiblities of the Oxy-Acetylene Torch in the Railway Shop.	Prof. J. M. Morehead	H. D. Vought	95 Liberty St., New York
Pittsburg	May 26			C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	May 12			F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	May 12			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	May 16	Annual Meeting and Election of Officers.		Jos. W. Taylor	390 Old Colony Bldg. Chicago
Western Canada	May 8			W. H. Rosevear	100 Chestnut St., Winnipeg, Man.

ANNUAL MEETING.

NEW ENGLAND RAILROAD CLUB.

The twenty-eighth annual meeting of this club was held at the Copley Square Hotel, Boston, Mass., on Tuesday evening, March 14. The following officers were nominated for the ensuing year: President, J. A. Droege, superintendent, N. Y., N. H. & H. R. R.; vice-president, R. D. Smith, assistant superintendent motive power, B. & A. R. R.; treasurer, Charles W. Sherburne, 530 Lever St., Boston, Mass.; finance committee, B. M. Jones, 141 Milk St., Boston, Mass., and F. A. Barbey, South Station, Boston, Mass. The membership of the club was given at 533 and its prosperity is evident by the continued increase in membership and the amount of cash on hand, which by the treasurer's report is $2,283.24.

INFLUENCE OF GRAVITY ON TRAINS DESCENDING GRADES AND BRAKE POWER NECESSARY FOR SAFE CONTROL.

CENTRAL RAILWAY CLUB.

John P. Kelly at the March 10 meeting ably summed up the various factors entering into the above problem in one of the most instructive papers which have been presented before this club. The subject is one deserving serious consideration in view of the fact that in modern railroading the day of the hand brake has practically gone forever, and that dependence is placed entirely on the automatic brake to control the motion of trains on heavy long grades as well as on level road. Mr. Kelly's final conclusion was that the braking power now employed on modern freight equipment is none too high for safe operation on heavy grades; hence the need for keeping the brakes in the best of condition to insure sufficient braking or retarding power for safe handling.

TEAM WORK IN TRANSPORTATION.

CANADIAN RAILWAY CLUB.

The necessity of this important adjunct to successful railroad operation was emphasized by C. Murphy, general superintendent of transportation of the Canadian Pacific eastern lines at the April 4 meeting of the above club. It was pointed out that if the heads of the different departments are not working in harmony, it will be found that the employees of their departments are at cross purposes, which implies disorganization and serious increase in cost. On the other hand, where the heads of the different departments are working together with the one end in view—that of obtaining the best possible results, the same attitude is largely reflected by their subordinates and a combination so strong is formed that nothing can stand up against it, with the result that the lowest possible cost of operation is attained. Mr. Murphy reviewed in turn each of the various departments and indicated reforms which might be made tending toward the general good.

CAR INTERCHANGE.

WESTERN RAILWAY CLUB.

A paper on the above subject by T. W. Demarest, superintendent of motive power, Pennsylvania lines, was read at the meeting of this club held February 21. The presentation was largely an analysis of the M. C. B. code of rules, and contained the amended rules governing the interchange of cars at Chicago which will become effective when approved by the General Superintendents' Association.

CONSERVATION OF HUMAN LIFE IN STEAM AND ELECTRIC RAILROAD TRAVEL.

RAILWAY CLUB OF PITTSBURG.

At the February 24 meeting of this club Guy P. Thurber presented a rather lengthy paper under the above title, which, after a résumé of collision and mortality statistics, resolved into a description of the Gray-Thurber system of automatic train control and cab signal. It will be recalled that a trial demonstration of this system was made on the Pennsylvania Railroad west of Allegheny during 1905 to prove out the principle of automatically controlling trains successfully by using the well-known principle of the electro automatic block signal. Mr. Thurber described the various details at considerable length and in very interesting fashion. A considerable discussion was accorded the paper which was appreciatively received by the club members.

CONCRETE FOR RAILWAY WORK.

NEW YORK RAILROAD CLUB.

The varied uses to which this material can be adapted in connection with railroad structures were presented in a very interesting paper by J. P. H. Perry at the April 21 meeting of this club. It was pointed out that although railroad officials have adopted concrete most extensively for bridges, retaining walls, abutments, culverts, track elevation and similar heavy work, they have been somewhat backward about using concrete for buildings on their lines. The author recommended a more extensive application in this line, and set forth the varied advantages which it possesses, particularly from the viewpoints of fire and waterproofness, sanitary qualities and cost.

THE FIRST AUTOMATIC SIGNALS ON A STEAM ROAD using alternating current for operating and lighting the signals, as well as supplying the track circuits, were installed on the Cumberland Valley Railroad between Lemoyne and Mechanicsburg, a distance of seven miles, in 1908, and have just been put in service. No batteries are used on any part of the Cumberland Valley Automatic Signal System and the maintenance expense is limited chiefly to the proper lubrication of the signal mechanism, and the care of the rail bonds and insulated joints.

BOOK NOTES

Proceedings of the American Railway Bridge and Building Association. Twentieth Annual Convention, held at Denver, Colorado, October 18-20, 1910. Published by the Association. C. A. Lichty, Secretary, 215 Jackson Boulevard, Chicago, Ill.

The proceedings, which comprise 197 pages 6 by 9 inches, embody in detail the work of the convention. The secretary's report is of interest showing the association to be in a growing and prosperous condition, the membership having increased in numbers during the past ten years from 171 to over 400, including membership in Canada, Mexico, Australia, New Zealand, China, India, Cuba, Panama and the Philippines. Several extremely valuable papers were presented during the session, including Embankment Protection, Cast Iron Pipe Culverts, Buildings and Platforms for Small Towns, Superelevation on Bridges, Hoops for Water Tanks, and Fireproof Oil Houses. The attendance was large and the number and value of the papers, with the animated discussion accorded them, combined to render the convention as a whole one of the most successful in the history of the association.

Industrial Plants. By Charles Day. Cloth 294 pages, 5 x 7½ inches. Illustrated. Published by *The Engineering Magazine*, New York, N. Y.

The latest manner of arranging and planning industrial plants, based upon a logical scientific method of analysis, is the problem with which this book deals, and unquestionably the presentation of the subject is adequate, with a full realization of the author's aims. The factors considered by Mr. Day concern the organic constitution of the factory, and are of more potential importance even than systems of management, which concern functional conditions. While these latter may be remedied, organic inefficiency embodied in the design and structure of the plant is incurable, and is imposed upon all later operations. Mr. Day defines in this book for the first time, in permanent form, the principles and the practical precepts of scientific plant construction. Chapters I to VIII, inclusive, have to do largely with industrial principles, and the manner in which the planning of industrial plants should be conducted to incorporate these principles. Chapter IX treats of certain more important problems that enter into the metal working trades. Chapter X includes descriptions of the principal points of interest presented by a number of plants selected as illustrating the trend of modern progress, and chapters XI and XII bear upon the relationship of client and engineer. The development of the subject as presented is thorough and the book on the whole is a unique and valuable addition to such literature. The inclusion of a volume upon works construction in a library of "Works Management" is a purposeful recognition of the fact that efficiency and economy in manufacturing must be considered much more than the mere operation of the plant in which the processes of production are carried on.

Locomotive Breakdowns. By George L. Fowler and William W. Wood. Published by the Norman W. Henley Co., 132 Nassau St., New York, N. Y. Flexible covers, 270 pages, 4½ x 6½ in. Illustrated. Price, $1.00.

The seventh revised and enlarged edition of this exceedingly valuable book brings its subject matter strictly up to date, covering the latest developments in valve gears, superheaters and air brake practice. The chapter on questions and answers on the latter has been entirely rewritten, and is the result of long and careful study in selection, guided by years of experience. As this book is intended for the benefit of everyone in any way connected with the locomotive, the chapter on engine repairs is the premium to the shop and roundhouse men, illustrating a number of handy devices used in locomotive shop repairs, and while not coming within the scope of road emergencies, with which the book primarily deals, it may still be defined as of great value when time is an important element that demands instant recourse to the quickest means for effecting what practically amounts to emergency repairs.

PERSONALS

E. A. Moseley, secretary of the Interstate Commerce Commission, died at his home in Washington on April 18.

F. Hume has been made superintendent of machinery of the Fort Dodge, Des Moines & Southern R. R., at Boone, Ia.

George Worling has been appointed master mechanic of the Gainesville Midland R. R., with office at Gainesville, Ga.

G. C. Nichols has been appointed master mechanic of the Jonesboro, Lake City & Eastern R. R., at Jonesboro, Ark.

C. A. Wood succeeds C. W. Tessier as general foreman of the car department, National Railways of Mexico, at Aguas Calientes.

C. H. Montague has been made master mechanic of the Quincy, Omaha & Kansas City R. R., at Milan, Mo., vice A. W. Quackenbush.

D. L. Ringler has been made roundhouse foreman of the Trinity and Brazos Valley Railway at Teague, Tex., vice E. L. Critz, transferred.

James McGinnis, master boiler maker of the Santa Fe at Argentine, Kan., has been transferred to Topeka, Kan., with a similar position.

D. J. S. Brown, assistance superintendent of motive power of the Delaware, Lackawanna & Western R. R., died on April 2, at Scranton, Pa.

Z. A. Burrell has been made general foreman of the Atchison, Topeka and Santa Fe Ry. at Winslow, Ariz., vice A. J. Cunningham, resigned.

B. Smith has been appointed general foreman of the Kansas City, Mexico & Orient locomotive shops at Wichita, Kan., vice Ira Chambers, resigned.

M. R. Smith has been appointed master mechanic of the Monon shop at Lafayette, Ind., vice O. S. Jackson, resigned to accept service elsewhere.

N. Kirby has been appointed master mechanic of the Alabama, Tennessee & Northern R. R., with office at Panola, Ala., succeeding D. D. Briggs.

John C. O'Donnell has been made machine shop foreman on the Atchison, Topeka & Santa Fe Ry. at Richmond, Cal., vice M. W. McKenna, resigned.

Edward Hughes has been appointed purchasing agent of the Lehigh & New England R. R., with office at Lansford, Pa., succeeding J. B. Whitehead, resigned.

R. L. Doolittle, master mechanic of the Atlanta, Birmingham & Atlantic R. R., at Fitzgerald, Ga., has been appointed superintendent of motive power of that road.

E. O. Rollings, assistant master mechanic of the Louisville & Nashville Railway, at Howell, Ind., has been promoted to be master mechanic at South Louisville, Ky.

W. T. Kuhn has been made assistant master mechanic of the Lake Erie & Western Railroad shops at Lima, O., succeeding G. J. Duffy, appointed master mechanic at the same point.

O. H. Attridge, general foreman of the Atlanta & West Point R. R. at Montgomery, Ala., has been made master mechanic of the system, vice F. O. Walsh, resigned to accept service elsewhere.

William A. Elmendorf, for many years connected with the Illinois Central R. R., died in Chicago on April 8. He is said to have placed in service the first sleeping car used on the above road.

J. McCabe, formerly master mechanic at Harlem River, New York, New Haven & Hartford Railroad, has been transferred to New Haven as general road foreman of engines, vice E. W. Alling, promoted.

R. J. McQuaid has been appointed a foreman in charge of locomotive and car departments of the Rock Island Lines, with office at Rock Island, Ill., succeeding V. W. Ellet, resigned, to go to the Hunt-Spiller Manufacturing Corporation, Boston, Mass.

J. L. White, purchasing and supply agent of the St. Louis, Brownsville & Mexico. Ry. at Kingsville, Tex., has had his headquarters removed to Houston, Tex., and his jurisdiction has been extended to include the St. Louis & San Francisco lines in Texas.

E. W. Alling, formerly general road foreman of engines, New York, New Haven & Hartford Railroad, with office at New Haven, Conn., has been promoted to master mechanic of the Old Colony Division; headquarters, Taunton, Mass., vice D. R. Killinger, resigned.

CATALOGS

Tramrails in Foundry Practice.—The Rockwell Furnace Co. of New York has issued Bulletin T, which is descriptive of the Moyer Tramrail, as applied to modern foundry practice. Several interesting half-tones graphically illustrate the uses to which this construction can be put, and in particular its labor-saving features, which commend it to special attention.

Direct Current Generators.—Bulletin No. 461, issued by the Triumph Electric Co., Cincinnati, O., is fully descriptive of the Triumph direct current engine type generators, which are furnished in capacities from 30 to 1,000 kw. The illustrated matter, which is extremely well selected and to the point, is remarkably clear, and the text is in a form very easily comprehended. The bulletin will be appreciated by the many interested in this class of machinery.

Car Heating and Lighting.—The April issue of the Safety Heating and Lighting News, published by the Safety Car Heating and Lighting Co., of New York, N. Y., contains several very valuable illustrated articles on Pintsch mantle fixtures, corner berth lamps, and on the improvements of Pintsch mantle buoy lanterns. The object of the *News* is to place before railroad men matters of interest relating to lighting and heating railroad cars and allied subjects, and it is duly appreciated for the information which it contains.

Gas Engines.—A new 31-page catalog from the Bruce-Macbeth Engine Co., of Cleveland, Ohio, presents much valuable data in connection with the company's four-cylinder gas engine. The parts are taken up and described as they occur in the process of building, and the many accompanying half-tone illustrations of the various parts are a valuable addition to the text. The latter portion of the catalog contains some excellent photographs showing the application of the engines in connection with various manufacturing industries.

Thermit Welding.—The last number of "Reactions," the interesting quarterly publication by the Goldschmidt Thermit Co., of New York, N. Y., was devoted almost entirely to rail welding, but the present issue might well be called a crank shaft number. It illustrates and describes some particularly noteworthy repairs to this part which have recently been effected through the thermit process, and in addition to its usually artistic makeup, the paper is replete with a variety of valuable data. The locomotive section in particular will repay a perusal.

Locomotive Lubrication is the title of an extremely interesting and valuable little book written by W. J. Schlacks, which is being distributed by McCord and Company, of Chicago and New York. The book deals graphically with lubrication of valves and cylinders and journals; discusses the various friction bearing metals, and treats at some length on methods ot lubrication. An extensive description is accorded the system of force feed, and the efficiency of the latter is well set forth in the text and through numerous tabulated records of actual results attained in service.

Files.—One of the most artistic catalogs to reach this office in a long period has just been received from the Nicholson File Company, of Providence, R. I., illustrative of this firm's well known output. The catalog contains 92 pages practically devoted in entirety to illustrated matter. The latter is intended to place before users and dealers a comprehensive display of all kinds of files now in common use. The illustrations show, first, Nicholson increment cut files and rasps, then Nicholson X. F. files, Swiss patterns, followed by several pages of manicure files, and tools and specialties, all manufactured by this company.

Ball Bearings.—The Hess-Bright Manufacturing Co., of Philadelphia, Pa., has issued four additional leaflets, Nos. 1-A, 2-A, 18-B and 34-A in the general series No. 336, supplementing its previously issued valuable information in similar form on the general subject of ball bearings. These sheets respectively illustrate and describe mounting for radial load without thrust, mounting for combined radial and thrust loads, mounting directi ns, and electric motor and two journal mountings. It is requested that former sheets 1, 2, 18, 18-A and 34, which these new issues supersede, be destroyed by those holding them in reference files.

Railroad Electrification.—In Circular No. 1517 the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., has reproduced in the most artistic manner the series of talks and illustrations on the above subject which appeared in the technical magazines January 1 to March 1, 1911. This book is remarkable for the valuable information which it contains and equally so for the beauty of its many illustrations. The latter portray electric locomotives in actual service in the many localities, both at home and foreign, where Westinghouse installations have been made. It can be read with pleasure and profit by every railroad official.

The Jordan Spreader.—A very interesting little booklet has been recently issued by the O. F. Jordan Co., Chicago, Ill., descriptive of the merits of the above well known device, which is generally recognized as the most efficient and durable of its kind in the country to-day. Long experience in building these machines and operating them in leveling, spreading and ditching all kinds of material in various climates and under all kinds of weather conditions, have made it possible to constantly add improvements and new features. The latest type of Jordan spreader, its construction and possible range of work, is well illustrated in the catalogue through a number of handsome half-tones. The description of the spreader is very complete and the catalog in general is replete with useful information concerning this device.

Leather Belting.—The April number of *The Phoenix*, issued monthly by the New York Leather Belting Co., includes an exceptionally well executed photograph of fifteen of its experienced employes, not one of whom came with the company less than twenty years ago. One of the gentlemen pictured has seen forty-five years' service, and several have records of twenty-five years and over. The photo and the explanatory diagram occupy the middle facing pages of the paper and present an extremely attractive appearance. It was a happy conception well worked out, and is a graceful tribute to the long and faithful service of the experienced men who are necessarily past masters in the art of belt manufacture. *The Phoenix* contains its usual well assorted information on belt transmission and has several very interesting pictures of various belting applications.

Continuous Railway Frogs.—The Continuous Frog and Crossing Co., of St. Louis, Mo., has put out a very handsome illustrated catalog describing the Roach frogs and crossings, of which they are the exclusive manufacturers. This device provides an uninterrupted tread surface for traffic at intersection of rails, for both main line and turn-out, embracing all the properties of safety of the track itself, as though it was continued through at this point without intersection. It is intended especially for high speed main tracks, where both tracks are used by trains at ordinary or high speeds. This new design of frog is a track structure in the full acceptance of the term, and absolutely accomplishes that which has been sought from the earliest history of railroading, a device that would provide a safe continuous tread, at turn-outs and crossings, without impact and without the use of guard rails.

Electrical Machinery.—The General Electric Co., of Schenectady, N. Y., has issued three bulletins of exceptional interest, dealing with the application of its products. In No. 4815 are illustrated and described continuous and alternating current motors, and apparatus for controlling them when applied to machine tool operations. Bulletin No. 4817 describes the company's 75 h.p. direct current commutating pole railway motor, which represents the latest construction in this class of apparatus. Bulletin B 3038 entitled "Electricity on the Farm," is a very artistic publication and is fully explanatory of the subject. The bulletin is attractively bound and carefully illustrated, and owing to the immense economic importance of the subject treated, should prove of considerable interest to the farmer, consulting engineer and central station manager.

NOTES

American Steel Foundries Co.—At their meeting in New York on April 12, the regular quarterly dividend of 1¼ per cent. was declared, payable May 15 to stockholders of record April 29.

American Locomotive Co.—The office of this company in Chicago was on April 8 moved from the Railway Exchange Building to Suite 907-912 McCormick Building, Michigan Boulevard and Van Buren street.

Atlantic Equipment Co.—The Chicago office of the Atlantic Equipment Company, on April 8th, 1911, was moved from Railway Exchange Building to Suite 907-912 McCormick Building, Michigan Boulevard and Van Buren street.

Triumph Ice Machine Co.—J. F. Nisbet, publicity manager of the Triumph Electric Co., has been selected to take charge of the publicity and advertising department of The Triumph Ice Machine Co. also. These two departments were formerly operated independently of each other, but have now been combined.

Jenkins Bros.—After thirty years' continuous occupancy at 71 John street, New York, the business of these well known valve and packing manufacturers entirely outgrew the old home, and on April 17 removal was effected to the much larger building at 80 White street. The increased facilities afforded in the new location will no doubt enhance the perfect business service which it has always been the aim of the firm to render.

Triumph Electric Co.—A. H. Whiteside, who was for over four years manager of the power and electrical department of the Allis-Chalmers Co., in charge of sales and engineering, has accepted a position as assistant sales manager with The Triumph Electric Co., of Cincinnati, Ohio. Mr. Whiteside was previously Southern manager of The Sterling Boiler Co., with headquarters at Atlanta, Ga. He is a member of the Engineering Club of New York, and an associate member of the American Institute of Electrical Engineers. He assumed his new duties on April 1. Also P. F. Pier, foreman of the transformer department of the Canadian General Electric Co., Peterboro, Ontario, has left that company to accept a similar position with The Triumph Electric Co. The Boston office of The Triumph Electric Co. has been removed from 101 High street to 92 Pearl street. Mr. C. A. Cotton is district office manager. This change of location was made necessary by the large increase in the volume of business and the necessity of having larger and more commodious quarters.

Developments in Superheating During the Past Year

S. Hoffmann.*

Great strides forward have been made on American railroads in the introduction of superheated steam since the Master Mechanics' Convention of 1910, and a brief review of the tendencies developed and the experiences obtained might be appropriate. In the report of the Committee on Superheaters at the last convention, twenty American railroads were reporting on a total of eight hundred and five (805) superheater locomotives in service. European railroads reported on a little over five thousand locomotives in service or in course of construction. The number of superheater locomotives in Europe has since increased to about seven thousand, whereas, the number of locomotives equipped with superheaters in service or in course of construction on American railroads amounts now to approximately two thousand.

This rapid increase in the application of superheaters and the fact that some of the most important railroads, after extensive trials, are already specifying superheaters on all their new equipment and applying them to old power as well, indicates plainly that superheating cannot any longer be considered as being in an experimental stage.

Some of the railroads which during the past year ordered superheater engines are given in the following list:

Railroad.		Number of Superheater Locomotives Ordered.	Type of Engine.
Baltimore & Ohio R. R.		10	0880
Boston & Albany R. R.		1	2662
Boston & Albany R. R.		10	462
Canadian Pacific Railway	about	100	——
Chesapeake & Ohio R. R.		24	2662
Chesapeake & Ohio R. R.		1	462
Chesapeake & Ohio R. R.		2	482
Chicago & Alton R. R.		20	282
Chicago, Milwaukee & St. Paul R. R.		2	460
Chicago, Milwaukee & St. Paul R. R.		5	280
Chicago & North Western R. R.		25	462
Chicago & North Western R. R.		30	280
Chicago, Rock Island & Pacific R. R.		50	462
Chicago, St. Paul, Minneapolis & Omaha		6	460
Chicago, St. Paul, Minneapolis & Omaha		2	462
Delaware & Hudson Railway		1	280
Delaware & Hudson Railway		1	460
Delaware & Hudson Railway		4	0880
Florida East Coast R. R.		5	462
Illinois Central R. R.		40	282
Illinois Central R. R.		5	462
Lake Shore & Michigan Southern Ry		20	462
Lake Shore & Michigan Southern Ry		10	280
Minneapolis, St. Paul & S. Ste. Marie		21	280
Minneapolis, St. Paul & S. Ste. Marie		16	462
Northern Pacific R. R.		18	462
New York Central & Hudson River R. R.		31	462
New York Central & Hudson River R. R.		25	2662
Pennsylvania Railroad Company		2	462
Pennsylvania Railroad Company		1	2882
Pittsburg & Lake Erie R. R.		5	460
Pere Marquette R. R.		25	280
Pere Marquette R. R.		5	462
St. Louis & San Francisco R. R.		12	280
Southern Railway Co.		58	282
Southern Railway Co.		2	462

This table clearly indicates that most of the superheaters have been applied to the more powerful types of engines, i. e., Mallet, Mikado and Pacific type engines. The steadily increasing demand for locomotives with increased hauling capacity requires boilers of increased steaming capacity and cylinders of larger diameter. Both requirements can be fulfilled by the application of the superheater, which not only increases the steaming capacity of the boiler averaging about 25 per cent., but at the same time permits the use of larger cylinders. because the superheat prevents the cylinder condensation. In this manner the introduction of superheating opened a new field for further increase in power of these types of engines without overtaxing the capacity of the fireman. This is particularly the case with Mallet locomotives.

Two methods of superheating have been experimented with on Mallet engines: Superheating of the receiver steam in connection with a feed water heater, and the high degree superheating of the high pressure steam.

The first method has the disadvantage that it does not obviate the condensation in the high pressure cylinder, and that an intermediate superheater requires a considerably larger steam area than a high pressure superheater, in order to avoid wire drawing of the receiver steam. For this and other practical reasons in connection with the mechanical features of the receiver superheaters, only a few railroads have tried the application of the receiver superheaters. Most of the railroads use high degree superheating of the high pressure steam on Mallet locomotives. The superheat amounts to 200 degrees as an average, which is sufficient to give dry or moderately superheated steam on the low pressure side, but at the same time does not leave too much superheat in the low pressure steam to prevent the use of the ordinary slide valves on the low pressure cylinders. The application of superheaters to Mallet engines has been so much of a success from the start that practically all Mallet engines built during the past few months have been equipped with superheaters, and the application of a superheater is already almost considered as a necessary feature for an efficient Mallet engine.

Regarding the degree of superheat which is mostly favored on all types of engines there is a decided tendency noticeable toward the use of higher degrees of superheat, and averaging 200 degrees above the saturation point is the superheat generally considered as the most efficient. In this connection it should be remembered that the coal saving is not proportional to the degree of superheat, but increases more rapidly than the degree of superheat. This point has been very clearly brought forward in a paper on "Locomotive Performances Under Different Degrees of Superheat," read before the last Master Mechanics' Convention by Professor Endsley. On the other hand, actual experience with high degree superheaters has proven that, contrary to many predictions, the use of high degrees of superheat has not developed any serious trouble with lubrication.

With respect to the type of superheater mostly used, it can be said that more than 80 per cent. of the superheaters built during the period under consideration were of the fire tube type. This type seems not only to be favored on account of its efficiency in developing high degrees of superheat in an efficient way, but it is also preferred from a roundhouse point of view.

The essential requirements for an efficient and practical superheater are the accessibility of the superheater parts themselves and the location of the superheater in such a way that the rest of the boiler does not lose its accessibility; at the same time the superheater parts must be arranged in such a way so as not to cause wire drawing of the steam.

The steam and coal economy obtained with superheater locomotives, which is equivalent to a corresponding increase of the

* First Vice-President Locomotive Superheater Co., 30 Church street, New York.

boiler capacity, has made it possible in many cases to reduce the boiler pressure.

Quoting from a report of Prof. Goss on "The Use of Superheated Steam in Locomotive Service":

"Neither steam or coal consumption is materially affected by considerable changes in boiler pressure, a fact which justifies the use of comparatively low pressures in connection with superheat."

Most of the superheater passenger engines mentioned in the foregoing list carry boiler pressures of from 180 to 200 lbs., whereas for freight engines pressures between 160 and 180 lbs. have been favored. In bad water districts even lower pressures have been used with a corresponding increase in the diameter of the cylinders. On Mallet compound engines, however, the tendency is to maintain the boiler pressures of 200 lbs. and more, even with the superheater applied.

Contrary to the general conception no trouble has developed with lubrication in connection with the higher degrees of superheat. All engines built were equipped with ordinary sight feed lubricators, and on simple engines, as a general rule, five feed lubricators having two outlets to the steam chest and two outlets to the cylinders, have been applied. With regard to steam chest lubrication it is considered better practice not to bifurcate the oil pipe, but to let the oil enter into the steam cavity at the center of the steam chest.

One of the latest innovations in connection with the application of superheaters is the use of outside steam pipes. Most of the superheater engines built during the last few months have outside steam pipe connections to the cylinders. The following advantages of this arrangement are apparent:

No obstruction to the draft in the lower part of the smoke box; the joints between the steam pipes and cylinders are removed outside of the smoke box and any leakage occurring does not disturb the steaming of the engine, is easily noticed and remedied; the usual stresses in the cylinder saddle, due to the difference in temperature between live steam and exhaust passages are eliminated by removing the hot steam passage from the cylinder saddle.

These advantages of placing the lower part of the steam pipe outside of the smoke box are so appealing to the practical railroad men that it is safe to predict that the outside steam pipe connection will be a permanent feature of the American superheater locomotive.

The economical results obtained with superheater locomotives on several railroads showing savings in coal of 30 per cent. and more, would indicate that the application of superheaters to the larger sized American engines may even give better results than the superheaters applied on the smaller European engines. The larger size of cylinders causing increased losses through condensation may be one reason for this condition, and another may be looked for in the limit of the capacity of the fireman, which, on some American locomotives may already have been overreached, and caused uneconomical firing. This condition has been greatly improved by the coal and labor saving obtained by the use of superheated steam.

Among the many tests made during the year with superheater engines, one of the most reliable recently made with a Mallet engine equipped with fire tube superheater gave the following savings in coal:

DRY COAL PER DYNAMOMETER H. P. HOUR.

Speeds, Miles Per Hour.	Saturated Steam.	Superheated Steam.	Savings in %.
12.5	4.67	3.15	32.5%
15.0	4.75	3.56	25.0%
17.7	4.69	3.40	27.5%
Average	4.7	3.37	28.3%

These figures are the results of very careful tests where twenty-five trips were made on the same division of the road under conditions as nearly identical as possible, at first with the engine without superheater and afterwards with the same engine with the superheater applied.

Similar economical results have been obtained during the year with superheaters applied to passenger locomotives. But in the case of passenger engines it is not so much the coal saving which made these engines so successful, but the increase in power obtained and the better way in which the superheater engine handles the train. The great feature of the superheater locomotive is that its efficiency increases with the demand for power. If an ordinary engine without superheater is forced, its efficiency decreases on account of the increased wetness of the steam furnished by the boiler. The superheater engine, on the contrary, improves with increased demands, since the degree of superheat increases in proportion with the power the engine has to develop. In this connection the following quotation from the above mentioned report of Prof. Goss will be of interest:

"In operation the degree of superheat increases with the increased rate of power, which tends to conserve the steam supply as the demand for power is increased."

This flexibility is one of the main features which distinguishes the superheater engine from the ordinary simple engine and the compound engine; and is, besides the coal and labor saving, the principal cause why the superheater engines have in such a short time become a favorite with the men handling them.

THE TELEPHONE IN EMERGENCY SERVICE

The Delaware, Lackawanna & Western Railroad, besides being fully equipped for telephone train dispatching with the United States Electric Company's Gill selective system, has also in service the portable test sets for the use of its linemen, with the extension pole, whereby telephonic communication may be secured at any point on the line. With the portable telephone sets in the hands of men on the trains, the dispatcher, in the event of an accident, is enabled to talk with the man who knows all the facts in the case. Even if the man on the ground, by reason of the excitement incident to the emergency, overlooks some details or assigns to them minor importance, the dispatcher, having the greater experience, may, by his questions, elicit in conversation over the line, a detailed account of the situation which will serve as a basis for his action.

He will know whether to run the wrecker backward or forward, whether to approach the wreck with the crane ahead of or behind the engine, and whether the wrecked cars may be dumped off the right of way at the point of the accident, or will have to be dragged to some distant point. It is thus possible, with apparatus now available, to place train crews in quick communication with the dispatcher in the event of any accident or emergency affecting normal train movements, irrespective of the location of the nearest permanent telephone station.

INTERESTING RAILWAY STATISTICS

Railway equipment in 1910 included 59,133 locomotives weighing 4,271,000 tons without tenders, 46,890 passenger cars, 2,134,000 freight cars of an average capacity of 35 tons, and 104,093 company's cars. Since 1907 number of freight cars has increased less than 100,000, but there has been increase of one ton per car in average capacity.

June 30 reports to the Bureau of Railway News and Statistics gave number of railway employees 1,684,238, and compensation for year $1,137,016,508. This warrants an estimate of 1,754,400 employees for all railways, whose compensation was $1,172,181,000, being largest payroll in their history by over $100,000,000, and this before advances of last spring were fully in operation. Labor in 1910 received 42 per cent. of gross earnings. In five years since the bureau began its record average daily pay of all railway employees has increased from $2.07 to $2.29. Since 1894 average daily compensation of railway enginemen has increased 27.1 per cent., of firemen 35 per cent., of conductors 29.2 per cent., and of "other trainmen" 43.9 per cent. Increase for all classes was approximately 26 per cent.

Locomotive Building in Scotland is said to have been far from active during the past year. Some of the works have been kept going with difficulty, while about 1,000 fewer hands have been employed than during the previous year.

Saving by Oxy-Acetylene Welding

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

CAREFULLY KEPT RECORDS OF THE WORK PERFORMED BY THE OXY-ACETYLENE WELDING APPARATUS, IN USE AT THE COLLINWOOD SHOPS, HAVE SHOWN SOME VERY SURPRISING MONEY-SAVINGS RESULTING FROM THE GENERAL AND VARIED USE OF THE APPARATUS FOR MANY PURPOSES AT FIRST UNTHOUGHT OF.

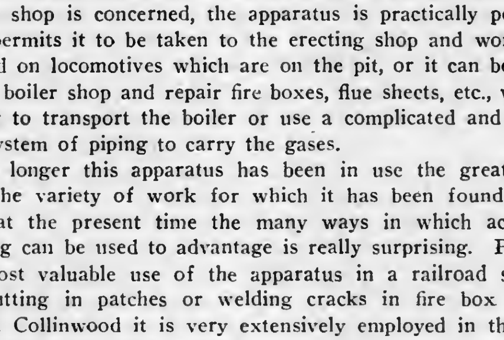
About two years ago there was installed at the Collinwood shops of the Lake Shore and Michigan Southern Railway an apparatus for welding steel and iron by the Oxy-Acetylene process. It consists of a stationary type generator in which acetylene is produced by the automatic feeding of calcium carbide into water, the necessary supply of oxygen being obtained in cylinders which, therefore, do not form a part of the permanent equipment. The complete equipment was furnished by the Linde Air Products Co.

The acetylene generator has a carbide capacity of 150 pounds, the acetylene being generated under a pressure of about 5 ounces per square inch. The oxygen is obtained in cylinders each containing 100 cubic feet under a pressure of 1,800 pounds per square inch. This pressure, however, is reduced when the apparatus is in use to about 18 pounds per square inch at the point where it enters the blowpipe, by means of an automatic pressure regulator, attached to the oxygen cylinder. The blowpipes are of the well-known Fouché type. The acetylene generating apparatus, as above stated, is of the stationary type, but it is mounted upon a platform so arranged that it can be lifted by the cranes and transported to different parts of the shop. As the oxygen cylinders can be trucked, so far as the interior of the shop is concerned, the apparatus is practically portable. This permits it to be taken to the erecting shop and work performed on locomotives which are on the pit, or it can be taken to the boiler shop and repair fire boxes, flue sheets, etc., without having to transport the boiler or use a complicated and extensive system of piping to carry the gases.

The longer this apparatus has been in use the greater has been the variety of work for which it has been found suited until at the present time the many ways in which acetylene welding can be used to advantage is really surprising. Possibly the most valuable use of the apparatus in a railroad shop is for putting in patches or welding cracks in fire box sheets. and at Collinwood it is very extensively employed in this way with most satisfactory results.

Some time ago it was decided to keep a record of the work which is being done by this apparatus for a period of time. Forms were prepared to show the gas consumption, time required, number of men, etc., as well as the expense of obtaining the same results if the welding apparatus was not available. A man was detailed to follow the machine for this purpose and sketches were made showing exactly the kind of work performed.

These reports are now very extensive, inasmuch as the machine is in almost constant use and a few examples selected at random are given below.



Welded in Countersink.

FITTED PLUGS WELDED INTO CAST STEEL CROSSHEAD SHOES.

The holes are countersunk about ¼ in. deep. Plugs are fitted and driven into holes, then welded in countersink using No. 10 Swedish iron wire for fusion. The holes are then re-drilled. This saves replacing with new castings, as has been customary.

The total cost of welding each shoe is as follows:

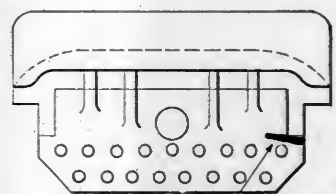
¾ of an hour labor at $.50½ =	$ .38
30 ft. gas, carbide and wire =	.60
Total cost of welding =	$ .98

Comparing this cost with the cost of replacing this casting, the following figures show a saving by welding process (scrap value has not been considered).

New Casting:		
Material	$2.50	
Labor	.35	
Total		$2.85
Total cost of welding		.98
Total saved by welding process		$1.87

WELDING CAST STEEL FURNACE BEARER.

The following weld of a crack 5 in. long was performed on engine 5871. The crack was chipped out in the form of a "V" the entire length. The same method and welding was used as in welding a firebox seam.



Weld on Cross Brace.
1½" Thick at Weld.

The total cost of labor and material for repairing the above fracture was as follows:

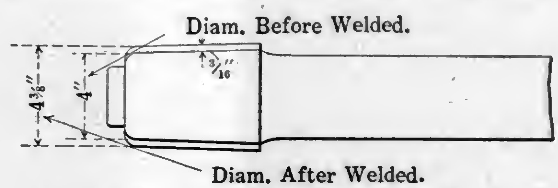
2 hrs. at $.50½ per hour =	$1.01
40 ft. gas and carbide =	.70
Total cost of welding	$1.71

Comparing the cost of welding with the cost of renewing the above casting, the following figures show the saving:

Cost of New Casting:		
Material	$47.17	
Labor	11.91	
		$59.08
Cost of welding		1.71
Saved by welding		$57.37

LAYER WELDED ON END OF PISTON ROD.

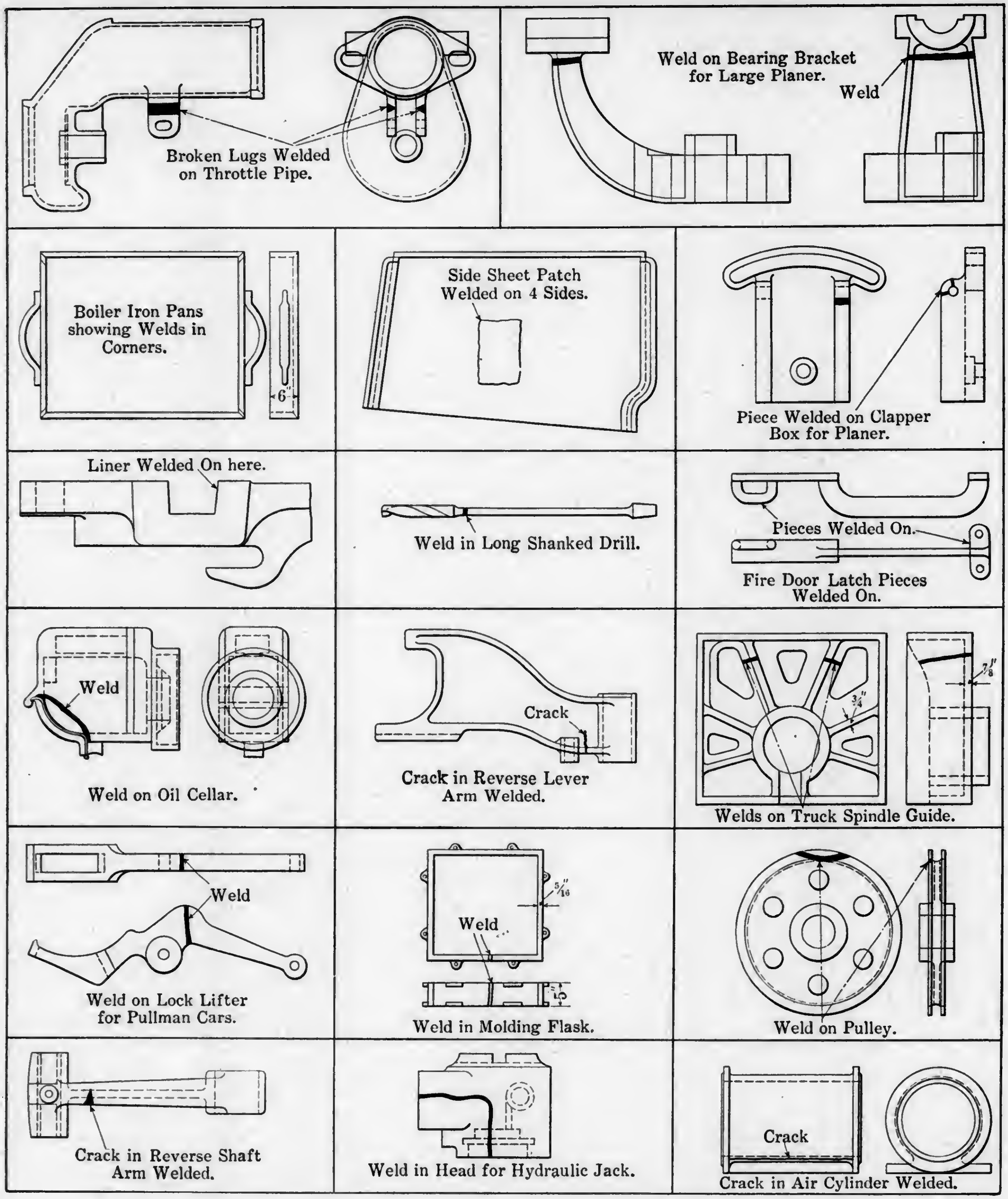
The end of the rod is heated in a forge and then the layer is welded on the full circumference and length of the fit, and as thick as necessary. No. 10 Swedish iron wire being used for fusion.



Layer 3/16" Thick on Cross-head End of Piston Rod.

Total cost of welding was as follows:

2½ hours of labor at $.50½ =	$1.26	
90 ft. gas, carbide and wire	2.00	
		$3.26



EXAMPLES OF WORK DONE BY THE OXY-ACETYLENE WELDING PROCESS AT THE COLLINWOOD SHOPS.

Under the old method of scrapping all rods worn below size, the cost of labor and material was as follows:

Labor	$2.24	
Material	3.00	
Total cost of new rod		$5.24
Total cost of welding		3.26
Total saving		$1.98

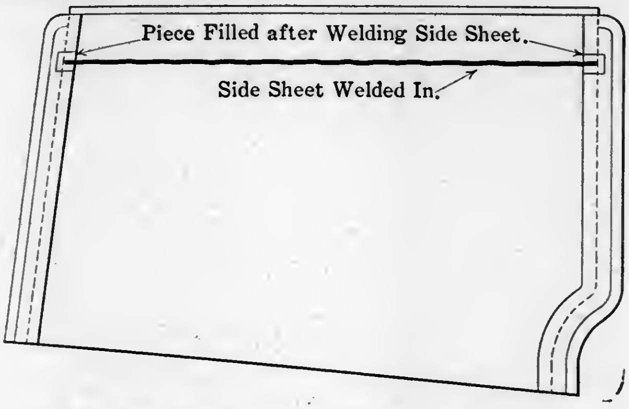
WELDING SIDE SHEETS TO CROWN SHEET.

The edges of the sheets to be welded are first beveled at an angle of 45 degs., then put in position and held on by means of temporary bolts through the outside sheet in such a way that the sharp edge of the bevel joints form a "V" shaped groove on the inside of the firebox.

A Fouché injector blow pipe is used, starting at one end, the seam is heated to the fusing point, and No. 10 Swedish iron wire run in for fusion.

This process is carried steadily forward until the end of the seam is reached. The metal, at frequent intervals, surrounding seam is heated to a cherry red and hammered. This relieves the strain due to uneven contraction of the metal.

On engine No. 5818 both side sheets were welded in. The length of one side seam being 102 in.



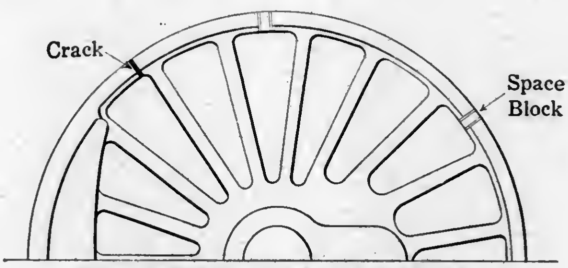
The following is an itemized cost of the above weld:

Labor—18 hrs. at 50½c. per hr. =............	$9.09	
Material—380 ft. gas, carbide =..............	6.91	
		$16.00

After welding no roundhouse repairs are necessary, such as caulking, replacing rivets, etc., and it is considered that the welded joints soon pay for themselves in this way.

Space Blocks.

The following figures show the total cost of welding 24 space blocks into the driving wheels of engine 4692:



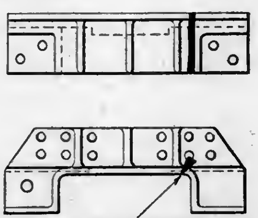
Driving Wheel Space Blocks Welded in. Also Crack in Rim Welded.

16 hrs. labor at $.50½ =.....................	$8.08
380 ft. gas, carbide and wire =................	7.00
Total cost of welding.....................	$15.08

Clearance in the form of countersink is chipped out on each side of block for welding, No. 10 Swedish iron wire being used for fusion. This insures against the old trouble of losing these blocks, which occurred frequently while engine was in service.

Coupler Support for Tenders.

The same welding material is used as when welding front furnace bearer, as they both are cast steel.



Weld on Coupler Support and Spring Case on Tenders.

The total cost of welding this casting is as follows:

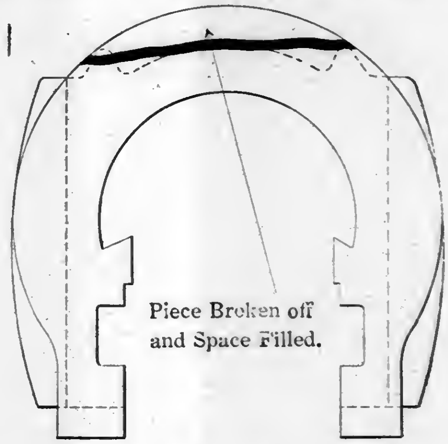
4 hours of labor at $.50½ per hr. =..............	$2.02
60 ft. gas, carbide and wire =..................	1.25
Total cost of welding =........................	$3.27

Under the old plan of scrapping these castings and furnishing new ones, the cost would be $10.23, including machine work. The saving effected therefore is $6.96.

Driving Boxes.

Piece of driving box was broken off and the space was filled up, as shown in the sketch.

The same method and material are used as when welding a



layer on piston rod, filling space up by using No. 10 Swedish iron wires as a fuse.

The total cost of welding this casting is as follows:

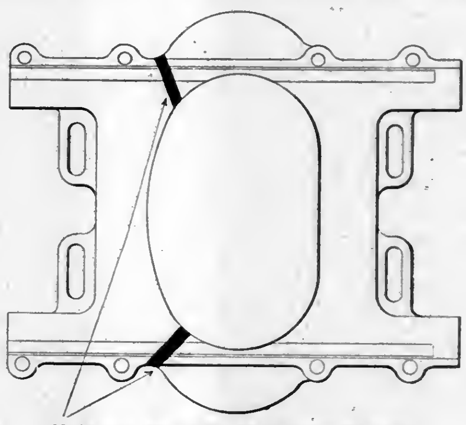
3½ hrs. of labor at $.50½ =.......................	$1.77
65 ft. gas, carbide and wire........................	1.40
Total cost of welding............................	$3.17

Under the old plan of scrapping boxes in this condition and furnishing new ones, the cost was $23.05, including machining. This method thus shows the following saving:

Cost of new casting..................................	$23.05
Cost of welding......................................	3.17
	$19.88

Franklin Fire Door.

The material is cast iron and in welding cast iron a special



Welds on Franklin Fire Door Frame.

cast iron alloy is used in conjunction wth Feroflux.

The cost of welding is as follows:

9½ hrs. of labor at $.50½ per hr. =................	$4.80
80 ft. gas, carbide and wire =......................	1.60
Total cost of welding............................	$6.40

The saving made in this case is as follows:

Cost of new casting..................................	$12.00
Cost of welding......................................	6.40
	$5.60

Welding Broken Lugs on Case of 5 h.p. Motor.

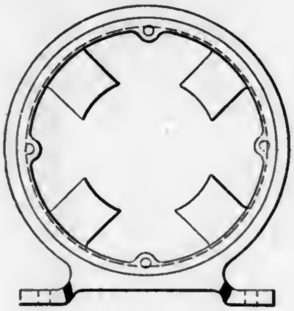
The same method and material is used as in welding the Franklin Fire Door, as they both are cast iron.

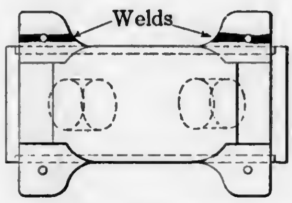
The total cost of welding is as folows:

3 hrs. at $.50½ per hr. =..........................	$1.52
45 ft. gas, carbide and wire =......................	.73
Total cost of welding =........................	$2.25

Under the old plan of scrapping broken cases and furnishing new ones the cost would be $100, showing a saving of $97.75.

Among the other pieces of work done during the past few months a few somewhat unusual jobs noticed in the reports are





as follows (some of these are shown in the accompanying illustration):

Liners welded on pedestal braces.
Pressed steel body bolster repaired.
Fire door latch repaired.
Water tight pan made from boiler iron.
Cracked reverse lever arm repaired.
Broken mould flask repaired.
Ventilator frame welded.
Letter press repaired.
Excess metal in cylinder steam passages removed.
Cracked reverse shaft arm repaired.
Crack in corner of pedestal repaired.
Spoiled main rod reclaimed.
Lug on coach trap door repaired.
Various broken parts of machine tools repaired.
Coupler lug lifter repaired.
Various heavy cast steel and iron parts of locomotives reclaimed and repaired.
Head of hydraulic jack repaired.
Tank well gooseneck repaired.
Broken injector parts repaired.
Broken long shanked drill welded.
Scale lever repaired.
Sand holes in casting filled up.
Broken wrenches repaired.
Broken vise jaws welded.
Broken crane pulley repaired.
Broken journal box repaired.
Car jacks repaired.
Lugs welded on throttle pipe.

PROPOSED BALANCED SIMPLE 4-6-2 TYPE LOCOMOTIVE OF MAXIMUM POWER

W. E. Johnston.

Owing to the increase in the weight of trains and consequent demand for more power, the possibility of securing greatly increased capacity in locomotives of the Pacific or 4-6-2 type by the use of the four-cylinder balanced principle would seem to be of even greater importance than the well-known advantages of smooth running and ease on track in the case of lighter locomotives.

The maximum tractive effort of two-cylinder locomotives of the 4-6-2 type is about 35,000 lbs., leaving a considerable gap between these designs and the 4-4-6-2 type with about 53,000 lbs. tractive effort now in service on the Santa Fe.

The design herein proposed is an attempt to secure maximum capacity for very heavy medium speed passenger service in a balanced locomotive of the 4-6-2 type without exceeding safe wheel loads or including any such undesirable features as bifurcated main rods or inclined cylinders. With suitable modifications this design may be made to give any desired tractive effort between 35,000 lbs. and 50,000 lbs. and meet any reasonable requirements as to speed.

While 200,000 lbs. on three pairs of drivers and a tractive effort of 47,600 lbs. may at first seem excessive, the maximum stresses in the track for this locomotive are actually less than frequently occur with ordinary two-cylinder locomotives.

Assuming, as a basis of calculation, a two-cylinder 4-6-2 type locomotive with about 150,000 lbs. on drivers as about the maximum for ordinary track, the excess counterbalance at crank radius figured by the Master Mechanic's formula will be about 200 lbs. to 250 lbs. per wheel. At a speed in miles per hour equal to the diameter of the drivers in inches and with a 26 in. stroke, the centrifugal force is 41.73 times the weight. For 200 lbs. excess counterbalance per wheel, the centrifugal force (w) is 8,346 lbs. per wheel or, approximately, 50,000 lbs. for six wheels. For 250 lbs. excess counterbalance, the centrifugal force per wheel is 10,432 lbs. per wheel or, approximately, 62,000 lbs. for six wheels. In Fig. 1, the vertical components of these forces which are effective in increasing or diminishing the pressure on the rail have been laid out for one revolution of a wheel starting and ending with the counterbalance on the horizontal center line, at which point the vertical component of the centrifugal force of the excess counterbalance is zero.

Taking the lower value of 200 lbs. excess counterbalance in order to be well on the safe side, we will have a total load of 150,000 plus 50,000 lbs., or 200,000 lbs., on the rails when the counterbalances are on the bottom quarter. Now, if the track can sustain a pressure of 200,000 lbs. from six drivers at one point, it can also at another or at all others, and 200,000 lbs. on six drivers on a balanced locomotive will be no more liable to damage the track than 150,000 lbs. on six drivers on an ordinary two-cylinder locomotive running at a speed in miles per hour equal to the diameter of the drivers in inches. As a matter of fact, passenger locomotives frequently exceed this speed and at extreme high speeds the wheel loads on the balanced locomotive which are not affected by the speed would be materially less than on the two-cylinder locomotive on which the centrifugal force of the excess counterbalance increases as the square of the speed.

As stated previously, the design proposed is intended for

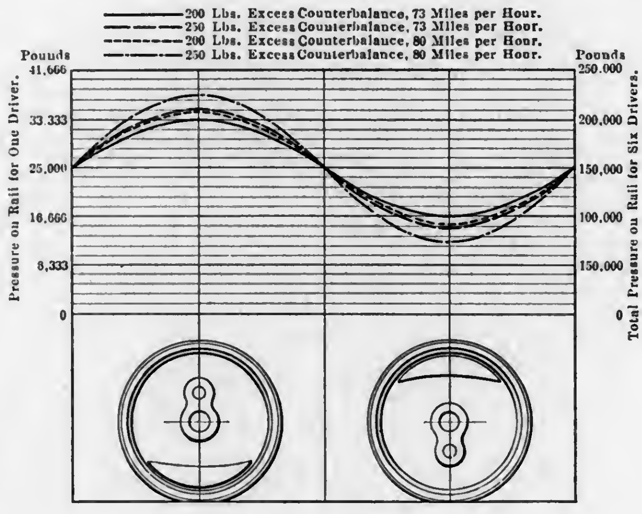


FIG I.

medium speed passenger service and therefore 73 in. drivers have been figured on. Also assuming that the locomotive will be required to start heavy trains, as high tractive effort as the weight on drivers will permit is desirable, say about 45,000 to 50,000 lbs., giving ratios of weight on drivers to tractive effort of 4.44 and 4.00 respectively.

The diameter of the inside cylinder is limited to about 18 in. by the space available between the frames. 18 in. x 26 in. cylinders with 175 lbs. boiler pressure and 73 in. drivers give a tractive effort of 17,150 lbs., leaving a balance of about 30,000 lbs. to be developed by the outside cylinders. 24 in. x 26 in. cylinders with 73 in. wheels and 175 lbs. boiler pressure give 30,450 lbs. tractive effort. Then a four-cylinder balanced simple locomotive with 18 in. and 24 in. x 26 in. cylinders, 73 in.

drivers and 175 lbs. boiler pressure will develop 17,150 plus 30,450 = 47,600 lbs. tractive effort, and the ratio of weight on drivers to tractive effort will be 4.2, which will be satisfactory.

All previous designs of four-cylinder balanced simple locomotives, as far as records are available, have had all four cylinders of the same diameter. This is not essential, however, as it is not necessary to balance the power developed in the inside and outside cylinders. The special and essential feature of the four-cylinder balanced locomotive is the balancing of the reciprocating weights, and this may be done with cylinders of different sizes by making the large piston as light as possible and adding to the small piston, or its crosshead, whatever weight is required to make the reciprocating weights for the large and small cylinders equal.

Having determined the weight on drivers and the tractive effort, the next step is to provide a boiler of sufficient capacity to supply the cylinders at the speeds required.

Fig. 2, the general plan of the locomotive, shows a boiler 80 in. in diameter at the first ring and 92 in. in diameter over the largest course, which will contain about 250 2¼-in. tubes and 27 5⅜-in. tubes 21 ft. 0 in. long. The distance of 4 ft. 6 in. from center of the cylinder to front tube sheet will give ample space for the superheater header without obstructing the draft. The 3 in. 0 in. combustion chamber with 21 in. 0 in. flues and 4 in. 6 in. from center of cylinder to front tube sheet and the sloping throat sheet give ample clearance over the rear drivers. A superheater has been included and is of such dimensions as will probably give about 150° F. superheat and about 20 per cent. saving in water consumption.

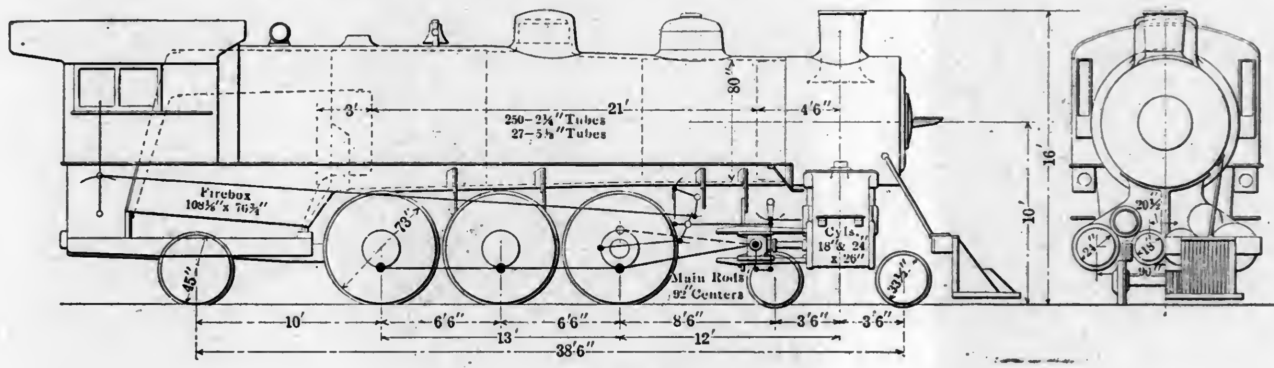


FIG. 2.

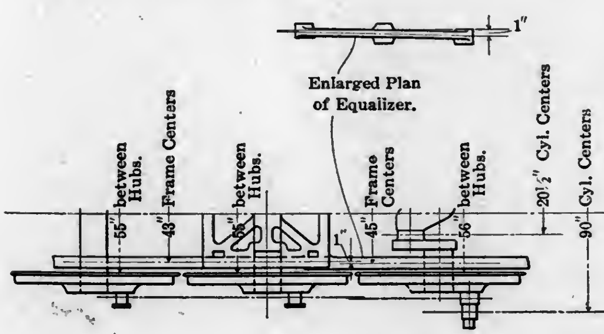


FIG. 3.

In order to promote free circulation, ⅞ in. bridges between the 2¼-in. tubes and 1¼-in. bridges between the 5⅜-in. tubes have been used, although considerably more heating surface could have been obtained by closer spacing. The ratio of tractive effort times diameter of drivers to heating surface and of heating surface to cylinder volume compare favorably with a number of recent superheater locomotives and indicate satisfactory steaming qualities. The fact that the combustion chamber is practically equivalent to an equal length of tubes should be considered in connection with the ratios involving heating surface.

One of the principal difficulties in a four-cylinder balanced locomotive of the 4-6-2 type has been to secure a sufficient length of main rod without using inclined cylinders or bifurcated rods in order to clear the front axle. In this design, this has been taken care of by making the distance from the front driver to the center of the cylinders 12 ft. 0 in., which permits a 92-in. main rod connected to the front drivers.

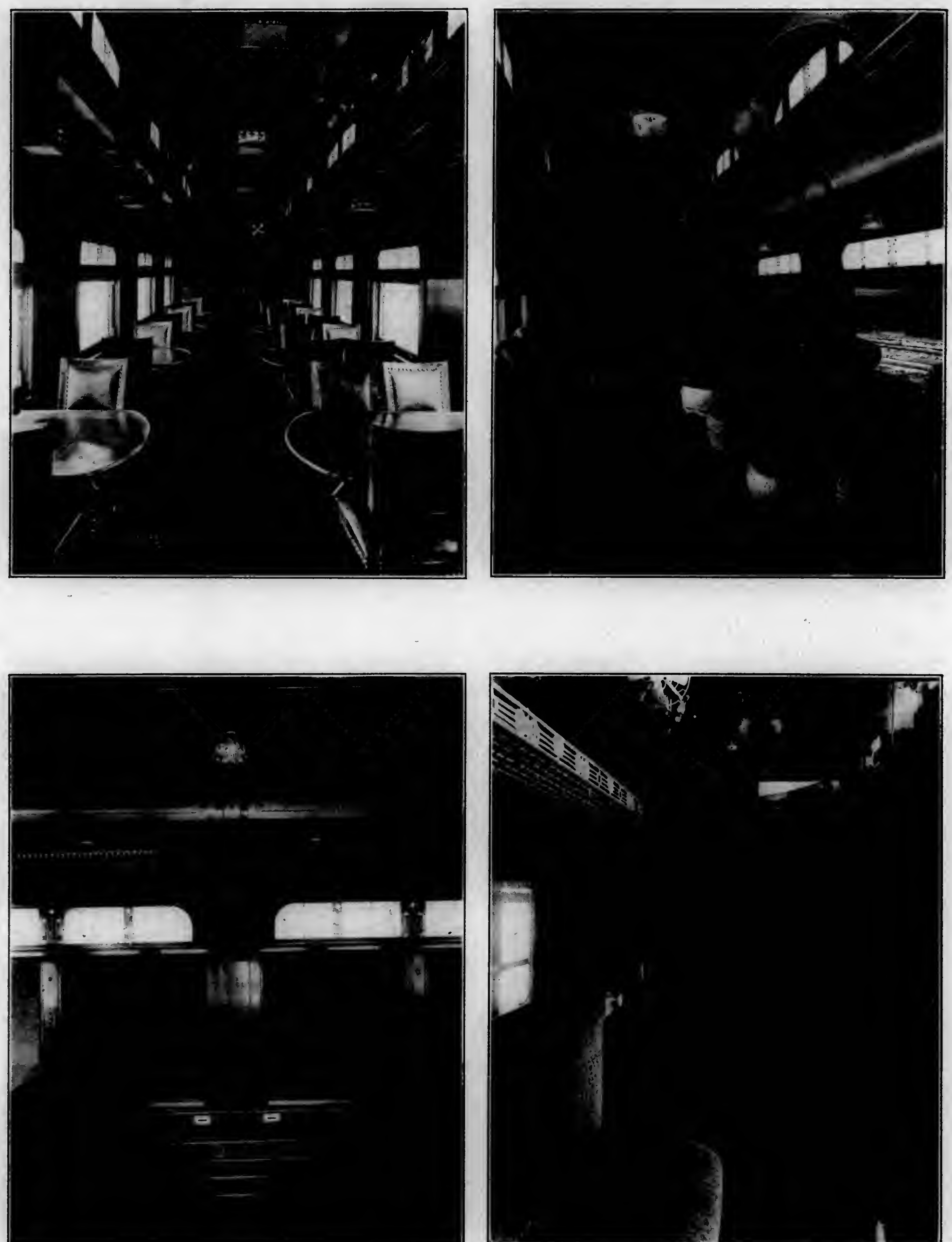
In order to get as large inside cylinders as possible, the distance between hubs on the front drivers has been made 56 in. with 13 in. diameter by 11-in. journals and 45-in. frame centers. Each frame is offset 1 in. between the front and middle drivers, giving 43-in. frame centers, 12 in. x 12 in. journals and the Master Mechanic's standard distance of 55 in. between hubs on the middle and back drivers. Whatever strains may be caused by the offset in the frames can be more than amply provided for in the cast steel crosstie over the middle axle and the waist sheets extending up to the boiler. To keep the load from the springs central on the driving boxes, the equalizer between the front and middle drivers is also offset 1 in. as shown to an enlarged scale in view Fig. 3.

The following table gives the principal dimensions of the proposed design:

GENERAL DATA.	
Type	4-6-2
Fuel	Bituminous coal
Tractive effort	47,600 lbs.
Weight in working order	285,000 lbs.
Weight on drivers	200,000 lbs.
Wheel base, driving	13 ft. 0 in.
Wheel base, total	38 ft. 6 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.0
Tractive effort times diam. drivers ÷ evaporating surface	830.0
Tractive effort times diam. drivers ÷ *equivalent heating surface	680.0
Volume, 4 cylinders	21.22 cu. ft.
Evaporating surface ÷ vol. cylinders	197.0
Equivalent heating surface ÷ vol. cylinders	241.0
Grate area ÷ vol. cylinders	2.66
CYLINDERS.	
Kind	Four-cylinder balanced simple
Diameter and stroke	18 in. and 24 in. x 26 in.
VALVES.	
Kind	Piston
Diameter	12 in.
WHEELS.	
Driving, diameter over tires	73 in.
Driving journals, front	13 x 11 in.
Driving journals, middle and back	12 x 12 in.
Engine truck wheels, diameter	33½ in.
Engine truck journals	6½ x 12 in.
Trailing truck wheels, diameter	45 in.
Trailing truck journals	8 x 14 in.
BOILER.	
Style	Extended wagon top
Working pressure	175 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	108⅛ x 75¼ in.
Tubes, number and outside diameter	250—2¼ in., 27—5⅜ in.
Evaporating surface, tubes	3,890 sq. ft.
Evaporating surface, firebox	300 sq. ft.
Evaporating surface, total	4,190 sq. ft.
Superheating surface	620 sq. ft.
Grate area	56.3 sq. ft.
Smoke stack, height above rail	16 ft. 0 in.
Center of boiler above rail	10 ft. 0 in.

* Evaporating surface + 1½ times superheating surface.

PLAIN FACTS connected with business do not count for much against fixed opinions.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*



GENERAL INTERIOR VIEWS OF STEEL PASSENGER EQUIPMENT ON THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

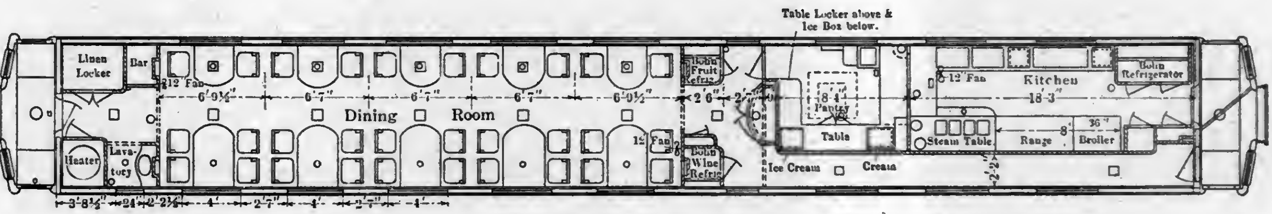
Steel Passenger Train Equipment

CHIGAGO, MILWAUKEE & ST. PAUL RAILWAY.

ON ELEVEN DIFFERENT KINDS OF PASSENGER TRAIN CARS OF COMPOSITE CONSTRUCTION RECENTLY BUILT FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, A STANDARD ALL STEEL UNDER-FRAME HAS BEEN EMPLOYED. MANY OTHER OF THE STEEL PARTS OF THESE CARS ARE ALSO STANDARD, RESULTING IN NOT ONLY A REDUCED INITIAL COST BUT ALSO IN GREATLY FACILITATING REPAIRS.

The recent inauguration of through passenger trains from Chicago to the Pacific Coast over the Chicago, Milwaukee & St. Paul, with its new extension, the Chicago, Milwaukee & Puget Sound Railway, is of particular interest on account of the exceptionally high character of the passenger train equipment which is being put into service. There has never been a new railroad of this size put into operation on which equipment of this class, and to the extent here employed, has been used. This company has received 243 steel passenger train cars divided up as follows:

84 coaches
40 twelve section drawing room, smoking room sleepers.
28 baggage cars.
20 diners.
18 ten section two compartment sleepers.
18 tourist sleepers.
18 baggage and mail cars.
4 parlor cars.
2 all compartment sleepers.
9 buffet observation cars.
2 chair cars.

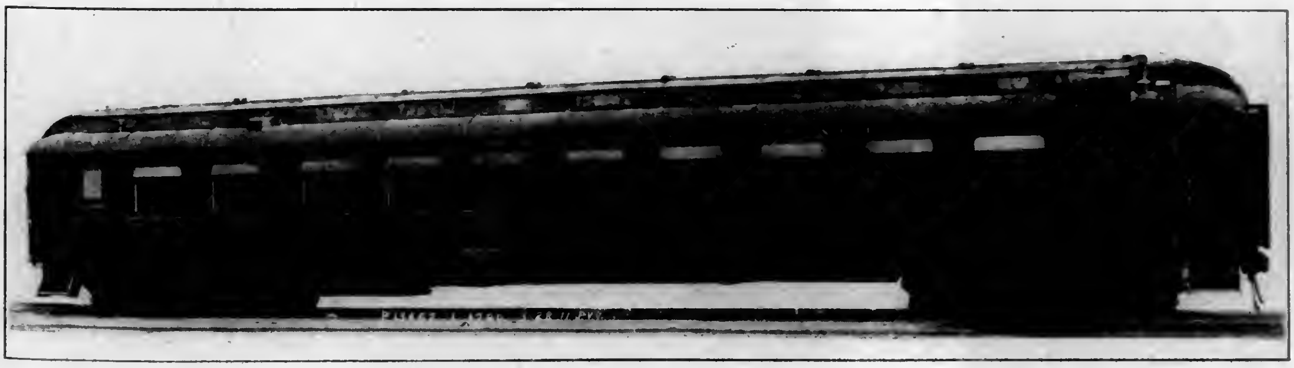


EXTERIOR VIEW AND FLOOR PLAN OF NEW STEEL DINERS—C., M. & ST. P. RY.

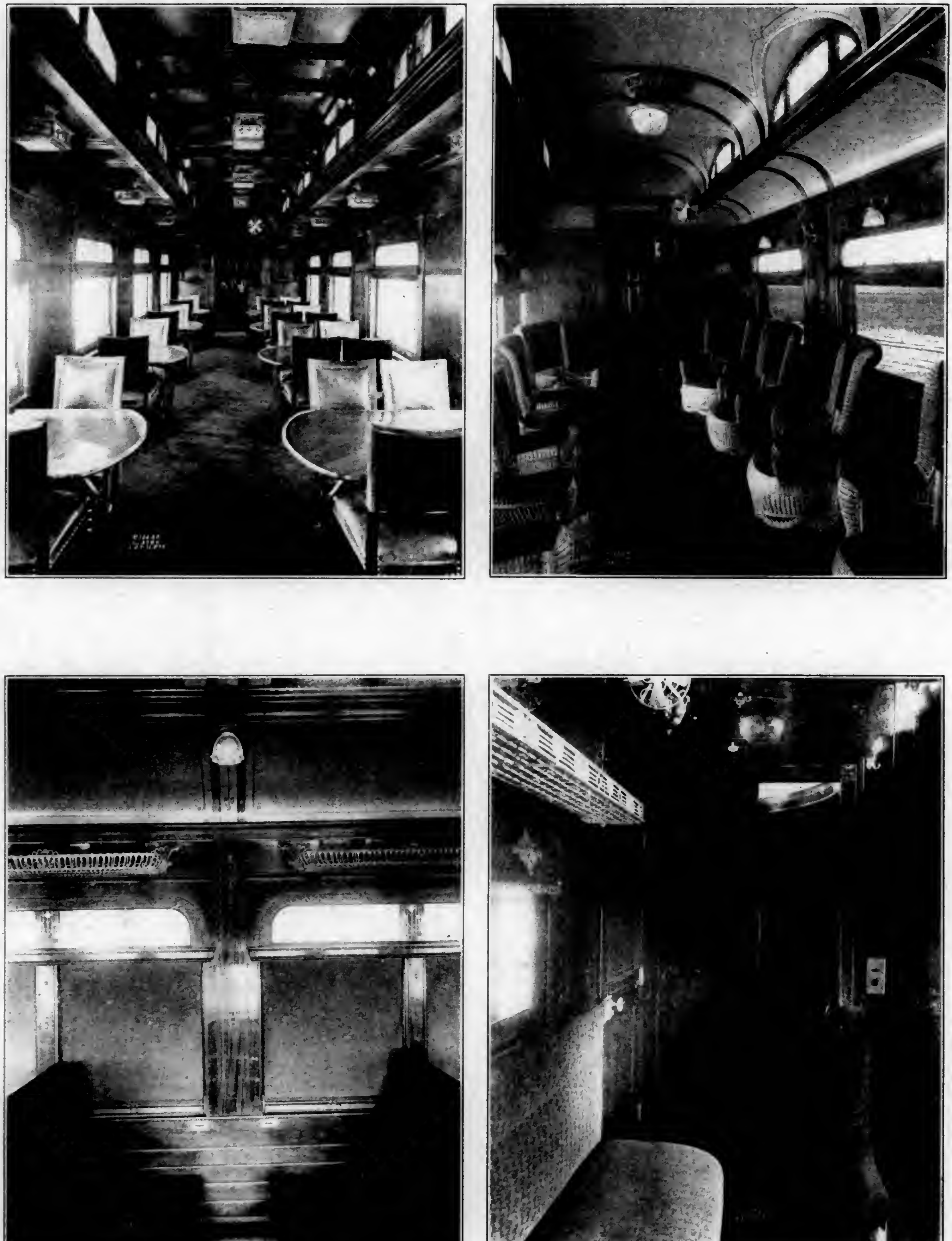
The main body of all of these cars, with the exception of the baggage and mail cars, which are 60 ft. 11 in. long, is 72 ft. 6 in. long. They all employ the same underframe and the same superstructure, except as the window and interior arrangement has made changes necessary in the latter.

These standard underframes are very similar and somewhat heavier than the standard frame adopted by the Pullman Company for this equipment,* and consist of two plate girder fish belly center sills connecting the steel castings making up the entire underframe structure from the bolster to the platform sills. These center sills are built up of 5/16 in. plate, 2 ft. 2 in. deep between cross bearers and spaced 18 in. apart. The compression members consist of two 4 x 3 x 5/8 in. angles riveted at the top of the web plate, while the tension members are

* For full illustrated description see AMERICAN ENGINEER AND RAILROAD JOURNAL, October, 1910, page 381.



COMPOSITE STEEL PARLOR CAR—C., M. & ST. P. RY.



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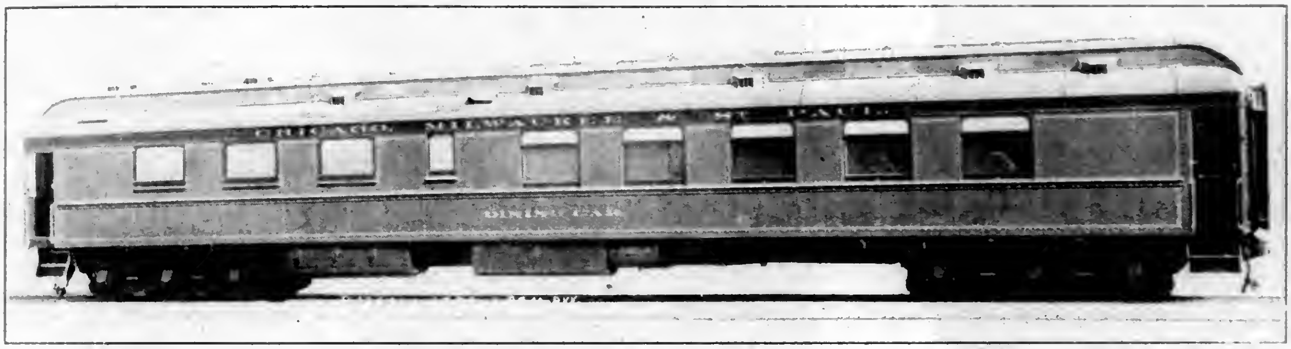
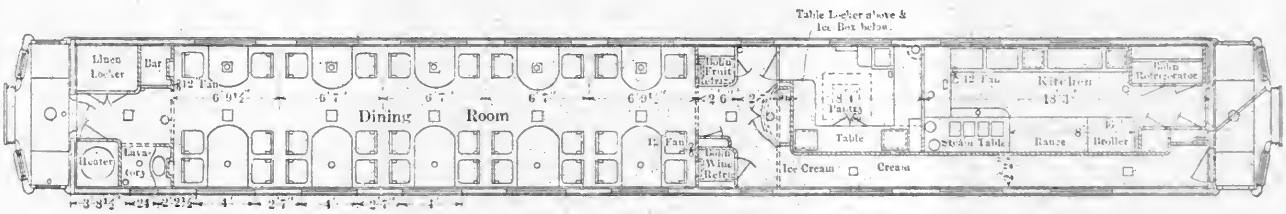
- 81 coaches.
- 40 twelve section drawing room, smoking room sleepers.
- 28 baggage cars.
- 20 diners.
- 18 ten section two compartment sleepers.
- 18 tourist sleepers.
- 18 baggage and mail cars.
- 4 parlor cars.
- 2 all compartment sleepers.
- 9 buffet [illegible] cars.
- 2 chair cars.

The main body of all of these cars, with the exception of the baggage and mail cars, which are 60 ft. 11 in. long, is 72 ft. 6 in. long. They all employ the same underframe and the same superstructure, except as the window and interior arrangement has made changes necessary in the latter.

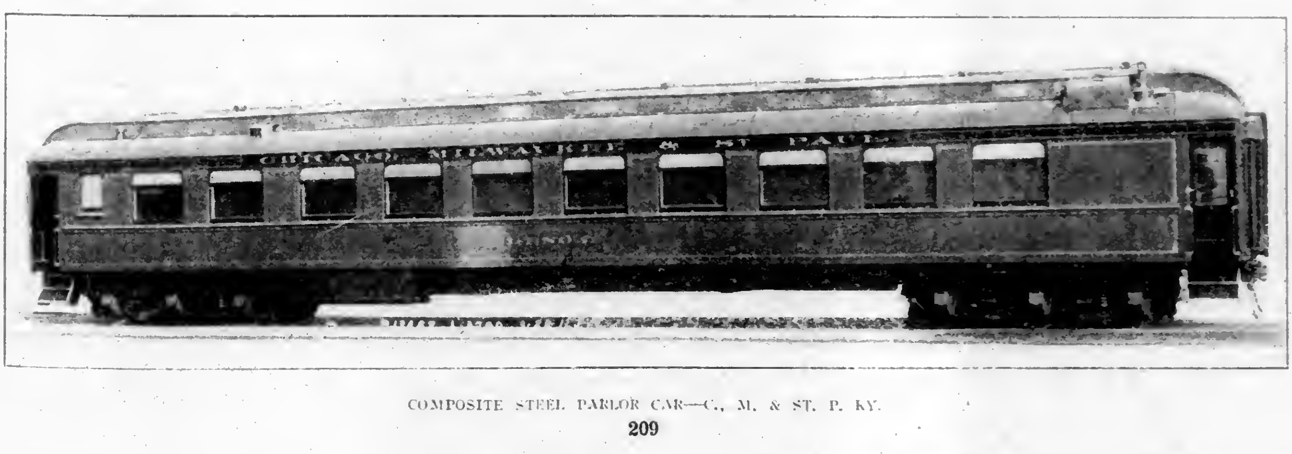




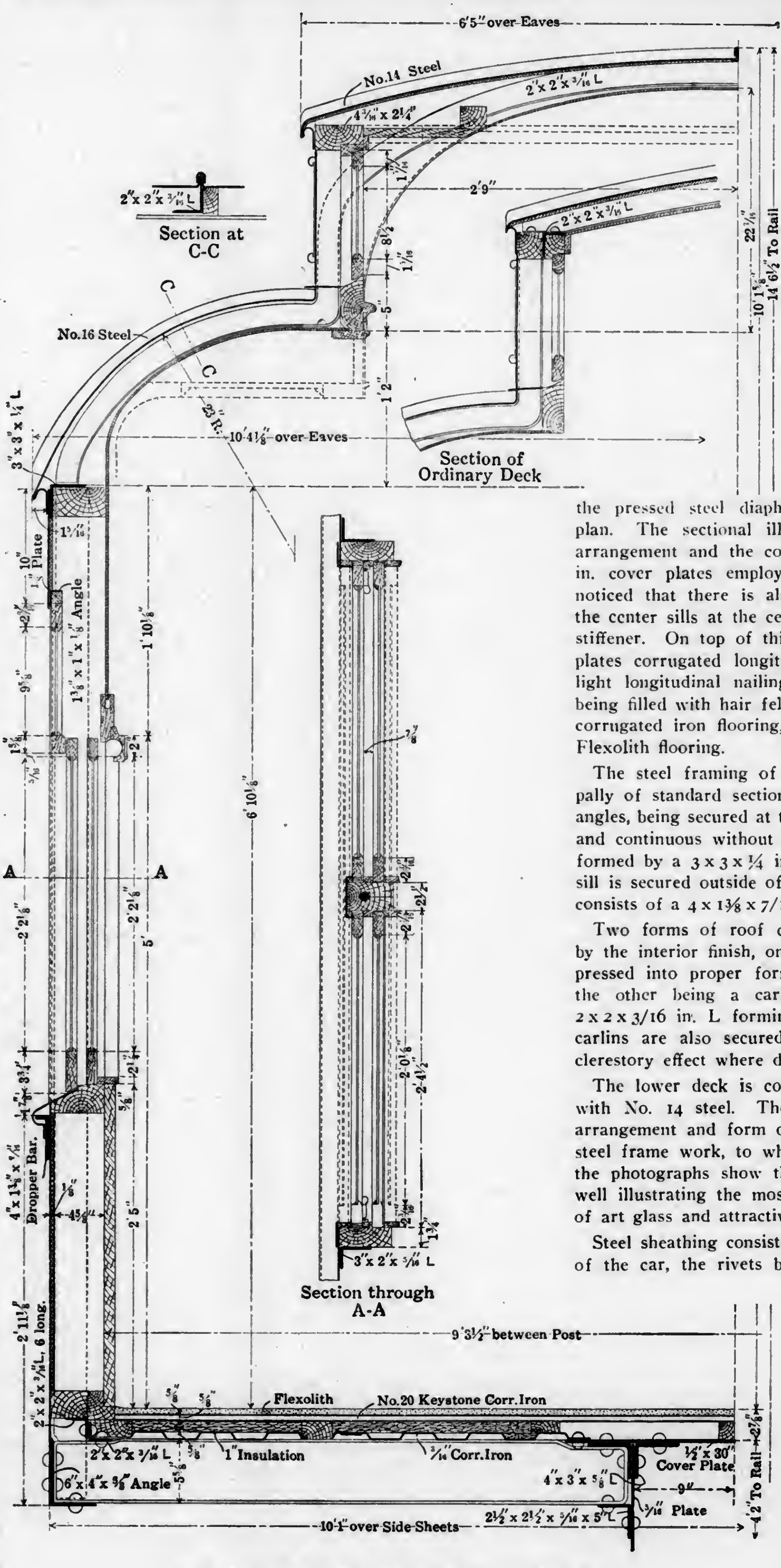
EXTERIOR VIEW AND FLOOR PLAN OF NEW STEEL DINERS—C., M. & ST. P. RY.

These standard underframes are very similar and somewhat heavier than the standard frame adopted by the Pullman Company for this equipment,* and consist of two plate girder fish belly center sills connecting the steel castings making up the entire underframe structure from the bolster to the platform sills. These center sills are built up of 5/16 in. plate, 2 ft. 2 in. deep between cross bearers and spaced 18 in. apart. The compression members consist of two 4 x 3 x 5/8 in. angles riveted at the top of the web plate, while the tension members are

* For full illustrated description see AMERICAN ENGINEER AND RAILROAD JOURNAL, October, 1910, page 381.



COMPOSITE STEEL PARLOR CAR—C., M. & ST. P. RY.



SECTIONAL ELEVATION SHOWING DETAIL OF FRAMING.

two 3 x 3 x ⅜ in. angles riveted at the bottom of the plate. There is a continuous top cover plate 30 x ½ in. covering both sills. These sills differ from the Pullman design only in the greater depth at the center, being 26 in. as compared with 22 in. The deepest section is uniform between needle beams, which in the case of the Milwaukee cars, are 19 ft. apart. On the Pullman cars they were 28 ft. apart, the Pullman underframe, however, being 1 ft. greater in total length. The side sills in the present case are 6 x 4 x ⅜ in., angles continuous for the full length of the underframe, while in the Pullman equipment 5 in. Z bars were employed. These side sills are tied to the center sills by two cast steel needle beams with a cast steel spacing block between the center sills as part of the structure, and by the pressed steel diaphragms arranged as is shown in the plan. The sectional illustration shows the construction and arrangement and the connections with the top and bottom ¾ in. cover plates employed at the needle beams. It will be noticed that there is also a cast steel spacing block between the center sills at the center of the car which acts simply as a stiffener. On top of this underframe is secured 1/16 in. steel plates corrugated longitudinally, over which is secured seven light longitudinal nailing strips, the space between the strips being filled with hair felt and over this is laid No. 20 keystone corrugated iron flooring, which in turn is covered with ⅝ in. Flexolith flooring.

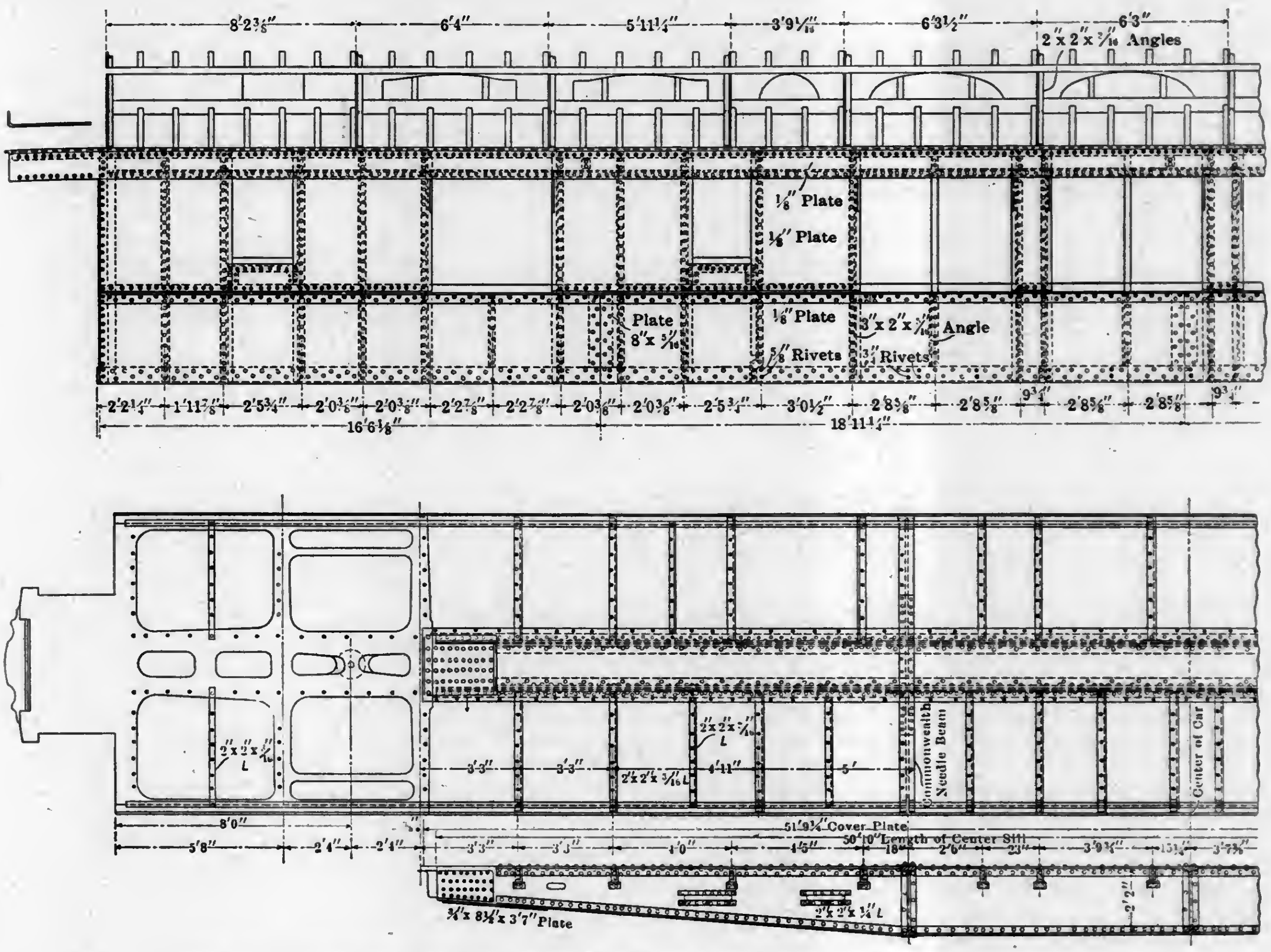
The steel framing of the superstructure is made up principally of standard sections, the side posts being 3 x 2 x 5/16 in. angles, being secured at the bottom, inside of the side sill angles and continuous without change of form to the plate which is formed by a 3 x 3 x ¼ in. angle. The belt rail at the window sill is secured outside of the side posts and steel sheathing and consists of a 4 x 1⅜ x 7/16 in. dropper bar.

Two forms of roof construction are employed, as required by the interior finish, one being a 2 x 2 x 3/16 in. angle carline pressed into proper form and continuous between plates, and the other being a carline extending from the plate to a 2 x 2 x 3/16 in. L forming the deck plate, to which the upper carlins are also secured, this arrangement giving the square clerestory effect where desired.

The lower deck is covered with No. 16 steel and the roof with No. 14 steel. The cross section of the car shows the arrangement and form of the wooden structure secured to the steel frame work, to which the interior finish is fastened and the photographs show the general appearance of the interior, well illustrating the most attractive inlaid decorations and use of art glass and attractive lighting fixtures.

Steel sheathing consisting of ⅛ in. plate is used on the sides of the car, the rivets being button headed, no attempt being made to simulate the appearance of a wooden coach. These plates are butt jointed with an 8 x 5/16 in. cover plate inside.

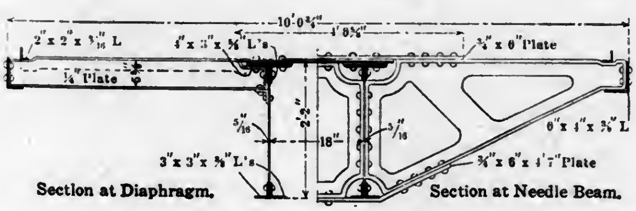
The end construction and vestibule arrangement offers no particular novelty. The body and corner posts are Z bars and the door posts, as well as the other two vertical members in the endframing are 4 in., 6¼ lb. channels, to which is secured the ⅛ in. steel end sheathing. The door and corner posts are set down into and are secured to the steel



STANDARD STEEL UNDERFRAME AND SIDE FRAMING OF MILWAUKEE STEEL PASSENGER EQUIPMENT.

casting to which the other posts are fastened by angles. The framing of the vestibule throughout is of steel.

In the interior arrangement of all of the cars the smoking rooms were installed on the right hand side to prevent passing



SECTIONS OF UNDERFRAME.

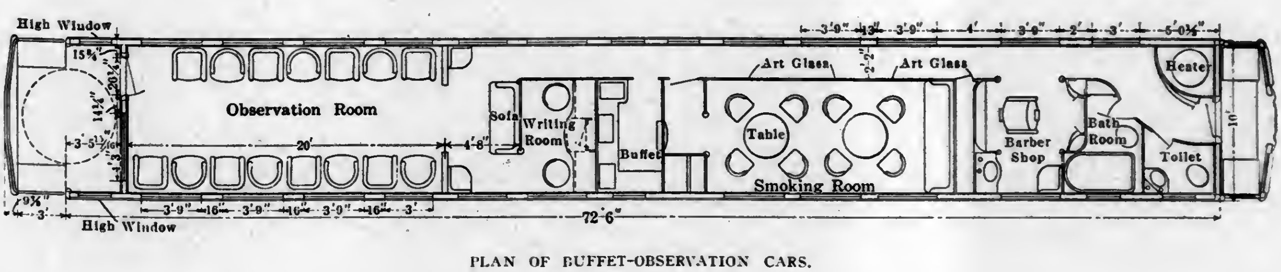
trains from obstructing the view. The typical plan of the buffet and observation car and the dining car are shown in the accompanying illustratons.

The cars are equipped with Chicago Car Heating Company's vapor system of steam heating and the electric lights are provided with current from a dynamo in the baggage car, according to the regular custom on the Milwaukee. Pintsch gas is installed and the sleepers and all heavier cars are equipped with a double set of Westinghouse brakes. Other equipment includes Chaffee centering device, Standard Coupler Co.'s type F buffing mechanism, Ohio couplers, Miner friction draw gear and Garland ventilators. The General Railway Supply Company furnished the Flexolith flooring and the steel trap doors.

These cars were divided between the Pullman Company, Barney & Smith Car Co., and the American Car & Foundry Co. the illustrations being those from the Pullman Company, the other builders, however, using practically the same construction.

The weights of the different classes are shown in the following table:

Baggage and mail	118,700 lbs.
Baggage cars	129,160 "
Coaches	135,000 "
Parlor cars	142,700 "
Dining cars	149,300 "
Tourist sleepers	148,000 "
10 section sleepers	156,200 "
12 section sleepers	152,300 "
Compartment sleepers	157,400 "

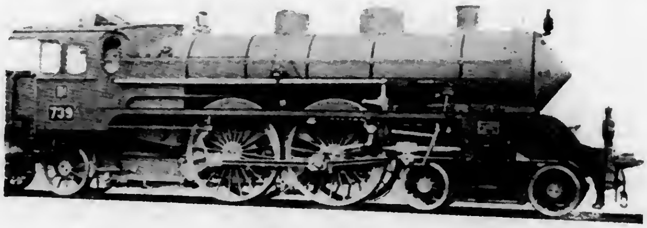


PLAN OF BUFFET-OBSERVATION CARS.

Practical Results of Wind Resistance Economies

W. R. McKeen, Jr., M. E., Member, Amer. Soc. Mech. Engrs.

If notice is taken of the changes in shapes of transportation mediums the world over, it cannot help but produce astonishment at the attention given and economies being obtained in this manner in all classes of vehicles. This has largely taken place within recent years since considerable useful data has been collected and published on the subject of wind resistance as applied to moving vehicles. The effect is particularly notice-



LOCOMOTIVE DESIGNED TO REDUCE THE EFFECT OF WIND RESISTANCE.

able in some recent designs of locomotives and cars, electric high speed cars, and even on automobiles.

Illustrating what has already been done, the accompanying views of recent designs of locomotives built with pointed boilers and cabs, for railways in Austria and Germany, also pointed front ends and round rear ends of recent developments in meritorious automobile shapes, are striking. The reduction of resistance by the design of flying machines, sea-going vessels and motor boats is producing great practical and economical results. but in general it is in the construction of railroad and traction line equipment where the wind resistance is such a large factor. and where the greatest economies are obtainable, that the smallest advance has been made in securing these possible economies by reducing wind resistance.

The Berlin-Zossen high speed electric propulsion tests of 1902 were elaborately conducted and gave the engineering world some useful figures. The wind tests carried out by the Electrical Commission during the St. Louis Exposition, while differently conducted, were useful and verified the German tests, by showing the enormous amount of power necessary to force a blunt end car against the atmosphere at high and medium velocities.

In a test made by an English automobilist of a scientific turn of mind, he discovered that the addition of thirty square feet of wind resistance to his 38.4 horse-power Napier car reduced his maximum speed from 79 miles per hour to 47.85 miles per hour.

In order to determine with exactness what the practical value

AUTOMOBILE BODY DESIGNED FOR HIGH SPEED.

of the shape adopted for the body of its motor cars might be, the McKeen Motor Car Co. recently conducted a series of comparative tests with different arrangements and body designs, which very strikingly prove the importance of close attention to this feature in all railway vehicles. The tests were conducted under the supervision of the writer, the observations being made by Mr. A. H. Fetters, Mechanical Engineer of the Union Pacific. The test of each design (Figs. 1 and 2) was made on a round trip of 80 miles, between Lincoln and Beatrice, Nebraska, under similar weather conditions. By means of an anemometer, thermometer and barometer, frequent readings were recorded showing the wind velocity, temperature and pressures. The gasoline was measured by U. S. standard gallon measure. Each trip was made at he same average speed of 41 miles per hour, requiring one hour and fifty-seven minutes running time. The car and engine were in the same condition before, after and throughout the entire test, all conditions surrounding the test being very favorable in securing accurate data. Briefly summarized. the following results were obtained:

Performance with the wedge-shaped or pointed front end, 3.48 miles per gallon of gasoline.
Performance with blunt form of front end, 2.48 miles per gallon of gasoline.
Extra gasoline consumption due to the blunt form of front end, 40%.

It must be here noted that this extra 40 per cent. of gasoline was necessary to keep the car with the blunt front end up to the speed which the same car made the previous day under similar conditions, but with the pointed front end. This extra power required to operate the blunt end car was obtained with a wider throttle. Details of the test are shown in accompanying table.

The comparative drifting tests with the two forms of front

MCKEEN MOTOR CAR WITH WEDGE END.

end down a six-mile gradient averaging about ¾ of one per cent. are of especial interest. In both instances the speed of the car was 40 miles at the top of the hill, and it was allowed to drift freely. With the pointed front end the car drifted from Princeton to Hanlon, 6.5 miles, in nine minutes, the velocity of the car gradually increasing from 40 miles per hour at the top of the hill, to 50 miles per hour while descending the grade. With the blunt form of front end, starting at the top of the hill with the same speed of 40 miles per hour, thirteen minutes were required to cover the same distance, the speed of the car gradually *diminishing* instead of increasing, as did the car with the pointed front end, and it was necessary to clutch in the engine to carry the car over the last 1⅛ miles.

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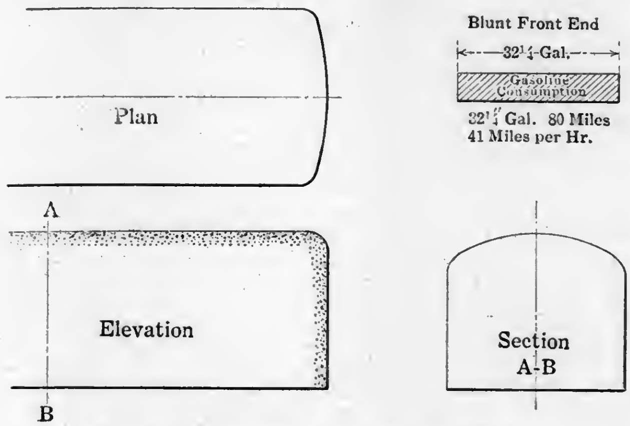
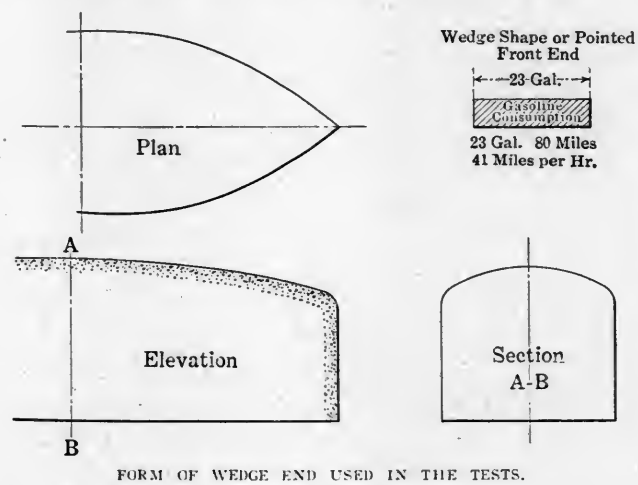
Total rise	230 feet
Average grade	36 ft. per mile
Maximum grade	53 ft. per mile
Average speed of car, up-grade	45 miles per hr.

A very important observation of Mr. Fetters, while on this test, was the unsteady riding effect produced by the blunt front end. The importance of the wind resisting design of the McKeen motor car, which also produces easy riding qualities, is more fully appreciated in a similar design of the monorail car, in which equilibrium and high speed were the important factors considered. The atmosphere has the same effect on the pointed front end as it has on the projectile, and one of the noticeable features of the McKeen motor cars has always been their steady riding qualities at high velocity, due to the steadying effect of the wind on the wedge-shaped end. This condition



FORM OF BLUNT END USED IN THE TESTS.

disappeared when the blunt front end was applied, and it was observed that the car nosed about considerably. This fact is too important to lose sight of when comparing the relative merits of the two forms of cars, and it is secondary only to the economy in gasoline consumption shown by the pointed front end. It will thus be seen that the experiments conducted with this motor car demonstrated in dollars and cents the actual economical advantage to be gained by the use of a properly shaped vehicle. Not a small feature of this economy is the rounded rear end, which almost entirely does away with



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With a single unit car it is much more important to consider head-end resistance, as some tests have shown that this head-end resistance is approximately 75 per cent. of the entire resistance, while with trains consisting of several cars, the side or surface friction necessarily gradually increases, according to the number of cars in the train, while the head-end area remains constant. It is thus seen that in long trains the proportion of head-end resistance is gradually reduced, but with a single unit car the head-end resistance, being so large a proportion of the entire resistance, is of prime consideration, and therefore anything that can be done to materially reduce the head-end resistance, especially on a single unit, self-propelled car, results in a direct and practical saving in the power necessary to drive the car at any speed above 15 miles per hour—this saving being proportionate as the speed increases, until, as shown at 41 miles per hour, a saving of 40 per cent. has been effected, by the proper attention to laws of resistance of a moving body through the atmosphere.

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BEATRICE TO LINCOLN.

Item.	Wedge Front End.	Blunt Front End.
Condition of weather	Clear	Clear
Condition of rails	Good	Good
Tempt. at beginning of run	43 deg.	47 deg.
Tempt. at end of run	58 deg.	53 deg.
Av. wind vel., ft. per min	3,950	4,809
Time leaving Beatrice	9:29 A. M.	9:16 A. M.
Time arrival Lincoln	10:29 A. M.	10:23 A. M.
Time on road	1 hr.	1 hr. 7 min.
Delays	2 min.	2 min.
Actual running time	58 min.	1 hr. 5 min.

LINCOLN TO BEATRICE.

Condition of weather	Clear	Clear
Condition of rails	Good	Good
Tempt. at beginning or run	60 deg.	64 deg.
Tempt. at end of run	64 deg.	72 deg.
Av. wind vel., ft. per min	5,448	3,800
Time leaving Lincoln	1:13 P. M.	1:31 P. M.
Time arrival Beatrice	2:12 P. M.	2:23 P. M.
Time on road	59 min.	52 min.
Delays	None	None
Actual running time	59 min.	52 min.

ROUND TRIP.

Actual running time	1 hr. 57 min.	1 hr. 57 min.
Av. wind vel., ft. per min	4,699	4,304
Amt. gasoline	23 gal.	32¼ gal.
Miles per gallon	3.48	2.48
Total mileage	80 miles	80 miles

Safety Record of the Illinois Central.—According to a recent statement issued by the Illinois Central Railroad it has not killed a passenger in its suburban service in 55 years. By this is meant that no person has been killed, while being transported as a passenger, through the fault of the management. The statement also discloses the fact that during 1910 the company carried 30,728,211 passengers without a fatality over a system of lines that cover a territory reaching from the Gulf of Mexico to the Great Lakes and west as far as the Missouri River.

The Massachusetts Institute of Technology has published a bulletin in regard to instruction during the months of June, July and August, supplementing the work of the regular school year. The requirements for admission and in general the work performed and the final examinations correspond with those of the regular school year. The summer courses are open also to persons not students in the institute who possess the necessary qualifications.

Progressing in the Right Direction.—Would it (scientific management) not hasten the Utopian condition which all right-minded men believe in and hope for; namely, that every man who is willing to work is entitled to a living and that no man is entitled to so much that somebody else must go hungry.—*David Van Alstyne before the Congress of Technology, Boston.*

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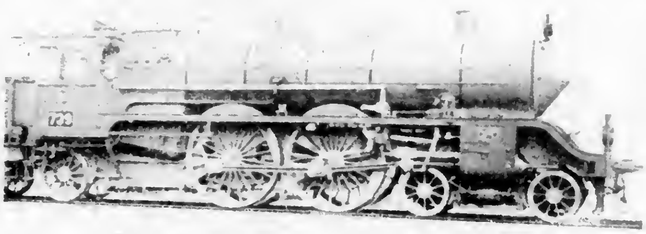

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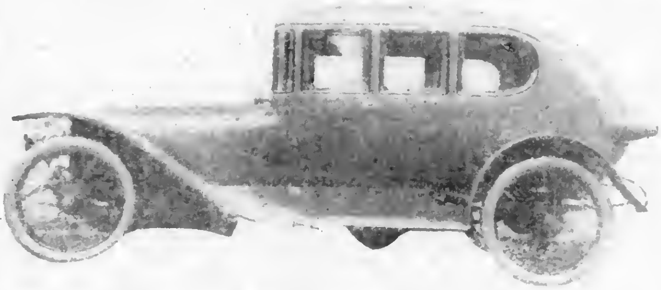

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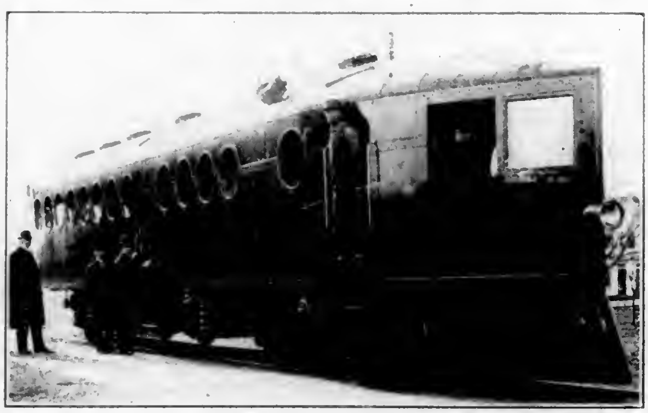

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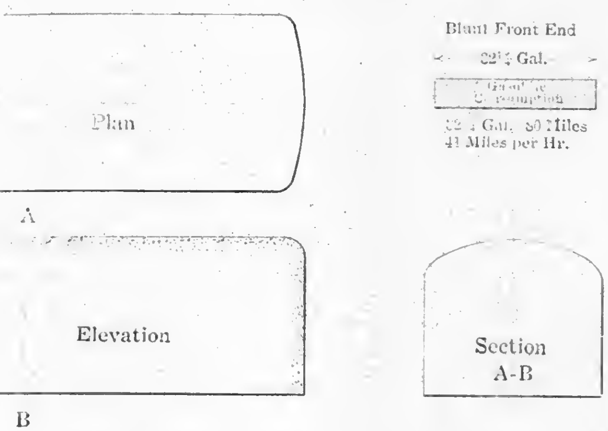

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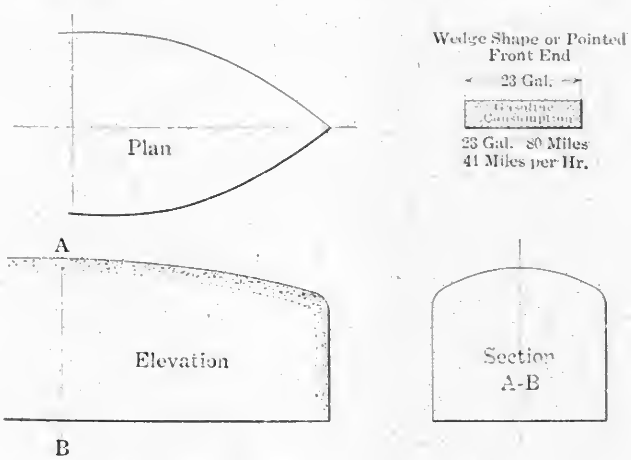

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Time on road	1 hr.	1 hr. [illegible] min.
Delays	2 min.	2 min.
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Tempt. at end of run	61 deg.	72 deg.
Av. wind vel., ft. per min.	3,418	[illegible]
Time leaving Lincoln	1:15 P. M.	[illegible] P. M.
Time arrival Beatrice	2:12 P. M.	[illegible] P. M.
Time on road	59 min.	[illegible] min.
Delays	None	None
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ROUND TRIP.

Item.	Wedge Front End.	Blunt Front End.
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Amt. gasoline	23 gal.	32½ gal.
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Total mileage	80 miles	80 miles

SAFETY RECORD OF THE ILLINOIS CENTRAL.—According to a recent statement issued by the Illinois Central Railroad it has not killed a passenger in its suburban service in 55 years. By this is meant that no person has been killed, while being transported as a passenger, through the fault of the management. The statement also discloses the fact that during 1910 the company carried 30,728,211 passengers without a fatality over a system of lines that cover a territory reaching from the Gulf of Mexico to the Great Lakes and west as far as the Missouri River.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY has published a bulletin in regard to instruction during the months of June, July and August, supplementing the work of the regular school year. The requirements for admission and in general the work performed and the final examinations correspond with those of the regular school year. The summer courses are open also to persons not students in the institute who possess the necessary qualifications.

PROGRESSING IN THE RIGHT DIRECTION.—Would it (scientific management) not hasten the Utopian condition which all right-minded men believe in and hope for; namely, that every man who is willing to work is entitled to a living and that no man is entitled to so much that somebody else must go hungry.—*David Van Alstyne before the Congress of Technology, Boston.*

DRIVING BOX LUBRICATION

W. J. Schlacks.

The fact that very material increased wear results from the use of other than the best lubricant is known to all who have used grease instead of oil for any length of time. The use of grease on these parts has very materially reduced the number of hot bearings, but a prominent railroad man asked me the other day if it were not a confession of weakness on the part of operating officials in adopting a tool-proof device of much less efficiency instead of insisting on the proper attention given a lubricating system of much greater efficiency.

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The pumping of the oil through the top of the box has in one case made possible the cool running of a new style locomotive, which was found impossible without it, on account of the even torque of the engine making it impossible to carry the lubricant to the point of working contact. In another case it had so increased the engine's efficiency that it made possible the hauling of ten passenger cars with the same facility that the locomotive with its driving journals lubricated with grease could haul nine cars. There are cases where this system of lubrication is used, where the reduction in coal consumption is commented on by the engineers and firemen that ride the engine, as well as the traveling engineers, and the road master mechanic.

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REAMER FOR INJECTOR THROTTLE SEAT

CHICAGO AND NORTH WESTERN RY.

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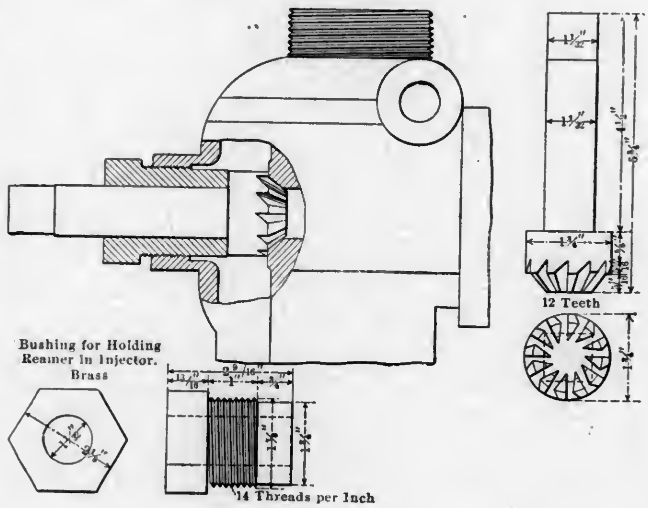

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Car Wheels and Axles---Boring, Turning and Mounting

A COMPREHENSIVE REVIEW OF THESE IMPORTANT OPERATIONS BASED ON CAREFUL STUDY, EXPERIMENTS AND TESTS, CONDUCTED WITH THE END IN VIEW TO SECURE IMPROVED DEVICES IN CONNECTION WITH A SAFE AND ECONOMICAL SYSTEM.

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As the majority of axles and wheels machined in railway shops are for repair work, i. e., fitting new wheels to axles, or refinishing cut journals, this class of work will be particularly considered.

It is, of course, recognized that safety is of the utmost importance, and that wheels must be fitted to axles in such manner as to insure their not working loose in service. However, the question of cost of work of this nature is also a consideration. The fact that in no case has a wheel been reported loose when mounted by methods explained below, would indicate that the system is entirely safe, and, considered as a whole, more economical than most of the previous methods. In comparing cost of wheel and axle work, especially repair work, life of the axle should be carefully considered. Any method by which the useful life of an axle can be prolonged being true economy. As an illustration, the useful life of an axle is that between size when new and that when worn or turned to unsafe limits. For axles used on 100,000 pound capacity cars, the finish turned parts differ in size about ¼ in. when new and when ready for scrap.

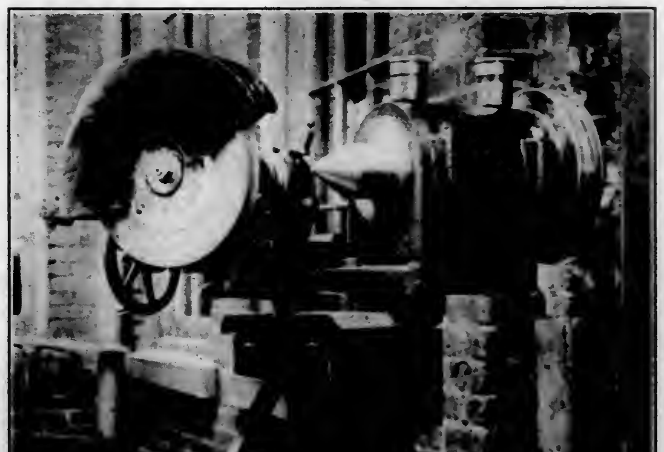
If the metal of the axle be carelessly turned, its useful life is shortened. The ¼ inch difference in diameter between a new and a scrap axle which constitutes its useful life, may be compared to a tube with wall ⅛ in. thick. A calculation will show that this metal, considering new and scrap value of axle, is worth about 50 cents per pound, also that each .001 inch in diameter of this tube is worth about 4 cents. Or, put it another way: Suppose two identical axles are to be repaired. One is turned 1/32 inch smaller than the other on account of lack of care. The carelessly turned axle is reduced in value $1.28 more than the carefully turned axle. While the diameter may not be the cause of scrapping, the question of removing the smallest amount of metal possible in repairing is of the utmost importance, and from the above figures the question of a slight increase in cost of machining should be secondary to saving metal.

Dents or marks on journals often necessitate removing unnecessary metal for their elimination. Unless care is exercised when handling mounted wheels, there is a possibility of flange of one wheel striking a journal of adjacent axles, and also in handling axles with bars there is a possibility of dents and scratches. A very good preventive for mounted wheels and axles loaded on cars for shipment is, never load different sized wheels and axles adjacent to each other without blocking between. The same will apply when stored on tracks, this assuming that wheels and axles are placed close, so that one wheel will strike the adjacent axle inside the wheel. In this event the journals of ordinary car axles will not strike, and if reasonable care be exercised, there should be no necessity for placing guards on the journals. Where bars or chains are used for handling finished axles, many dents and scratches may be avoided by covering the bars or chains with old air brake hose. A dented journal should call for an investigation.

To properly machine axles and wheels several points are necessary to obtain the best results, and attention has been given to the following: the speed of turning centers in axles, lathe centers, turning tools, micrometer calipers, lathe centers in line, boring bars, etc. The question of proper make of lathes and boring mills will not be considered as being a question generally decided by each shop. With any fairly good lathe or mill the work can be well done, if tools are kept in good state of repair.

The importance of true, properly ground and fitting axle lathe centers cannot be overestimated; in fact, no lathe center in any shop should receive more attention, for the reason that axles during their life may be turned several times on different lathes, and, if the angle of centers is not uniform, the center in axle will be badly and unevenly worn and make it difficult to do good turning. A case came to hand where a few axles were turned some .010 inch out of round. Investigation showed that the lathe on which they were turned had centers of about 85 degrees angle, and that the axles were centered 60 degrees. As a result, the axle only bore on the lathe center at end or had a line bearing. This line bearing soon wore unevenly, allowing the axle to work back and forth, and this was responsible for the eccentricity of the axle.

Several of the modern axle lathes have only dead centers where grinding in place is not possible. Also in many cases they are too large for the average tool room grinder, and as a result the centers are not given the necessary attention. Recognizing the fact that where ready means are provided for grinding centers they will be kept in better order, the grinding machine, Figure 1, was designed. This machine will only grind to 60 degrees included angle, being made this way purposely to prevent possibility of being set wrong. It is not expensive, and would be a desirable addition to any shop. While savings cannot be put down in dollars, there is no question but that the resultant better work will justify its use. Center gauges are cheap, and should be frequently tried on centers, and in



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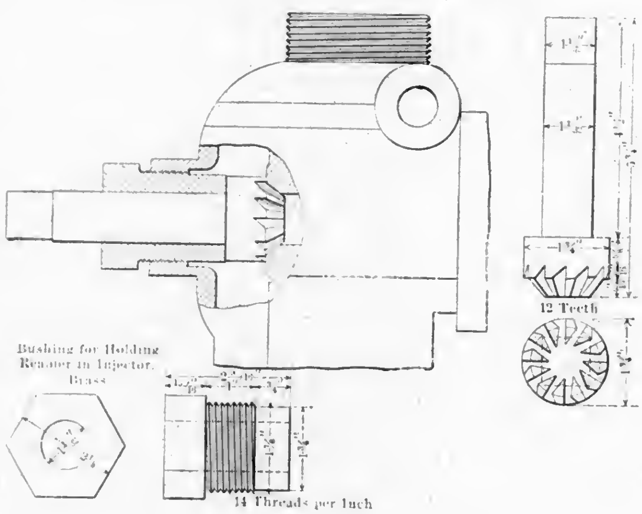

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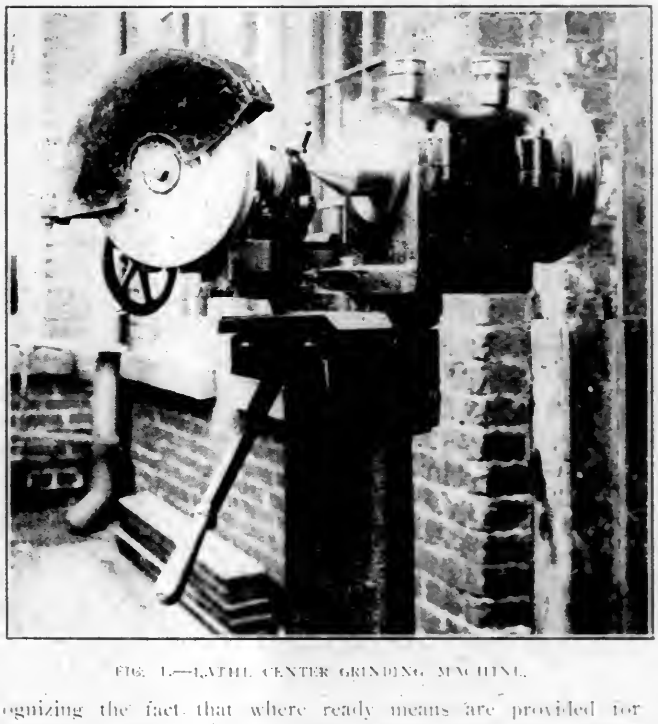

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event of the latter not being to proper shape or rough, they should be repaired at once.

Another point brought out was the necessity of having lathes in proper alignment to insure turning a journal or wheel seat same diameter for its entire length. The importance of proper alignment can be appreciated when we consider that to mount a steel wheel having 7 in. hole, or cast iron wheel of same size, the axle should be .007 and .015 inches approximately larger than the wheel bore, and also each .001 inch variation will affect the mounting pressure some 10 per cent. If the wheel seat be turned tapered it is not possible to properly caliper except to average diameter, which will rarely be a true indication of mounting pressure. Also if turned tapered an extra strain may be exerted on one part of wheel with the possibility of no pressure on other parts. Actual cases have been noted where wheels have been removed that only had a bearing for part of their length owing to taper turned axles, and while the wheels did not come loose in service it is a condition which if known to exist would be bad for the peace of mind. By proper care in maintaining lathes the damage that may result from turning tapered can be avoided, and good turning that can only follow with lathes in good state of repair will result in a saving in labor when mounting the wheels on the axles. A very satisfactory test for lathe alignment is to take two or three light cuts for the entire length of the wheel seat and measure the diameter with micrometers. For wheel seats there should never be a difference in diameter exceeding .003 inch.

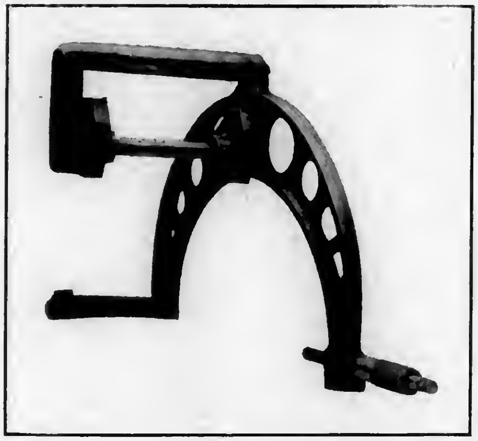


FIG. 2.—MICROMETER AXLE CALIPERS.

Tests made to determine the speed axle lathes should be run developed the fact that 45 r. p. m. was about the limit for car axles. The limit being the chattering of axle rather than cutting tool, as most any high speed steel will stand this speed with a stream of water flowing on the tool when taking light cuts, such as is generally necessary for repair work. The question of slow speed and coarse feed and fast speed and fine feed was also considered. For good work there is no question but that the fast speed and fine feed is the more desirable on account of avoiding large humps and hollows. A broad faced tool fed slowly may look satisfactory, but considering the fact that there is always a possibility of the workmen not setting the tool nose square, which is liable to result in the wheel only having a few points for bearing, and on the journal the burnishing wheel or other finish will have to push down or remove the high spots, the latter method is decidedly the better. In the writer's opinion the final cuts should never be taken with feed less than 16 pitch.

Proper inspection of axles is, of course, important, but to be of value and keep a shop up to proper standard, limits should be established. Inspection for diameters cannot well be made with machinists' calipers on account of being too slow, and embodying too much personal element. Without a question of doubt micrometer calipers are the more satisfactory for such work. At first glance this may appear a refinement, but experience has proven their value.

In order to reduce the time necessary to make micrometer caliper measurements, the calipers, Fig. 2, were designed by the writer, these having in addition to the ordinary micrometer an extra anvil set at right angles to the line through micrometer, which insures the caliper being at right angles with the object measured, and also stops which may be turned so that the distance from the stop to the center of the axle shall be approximately the radius of the latter. With the calipers illustrated, one set of stops is approximately correct for axles 6¾ to 7 inch, one set for axles 6¼ to 6½ inches. These stops can be made for any desired diameter within range of the micrometer screw. In service the caliper is placed over axle with the anvils and the stops resting on axle. It is then screwed down until the ratchet clicks, when it is removed and reading taken. This caliper obviates all "feeling" for measurement, such as is necessary with ordinary micrometers, and reduces the possibility of error. In practice six measurements can readily be made, and results read in one minute. By use of the caliper in question an exact reading to .001 inch can be made and recorded very much quicker than by machinist's calipers, the latter being only of value in mounting wheels when compared or adjusted to calipers previously set to some particular wheel-bore.

A method of inspection that has worked out very well in practice has been as follows: Each wheel seat was calipered about 1 inch from dust guard seat, at middle, and about 1 inch from end nearer center. These readings to agree within limit of .003 inch, the average size being chalked on the axle for information when mounting wheels. Should these readings vary over .003 inch, the axle is sent back for returning. The journal to be inspected in a similar manner, but without recording sizes. No particular trouble can result from the two ends of axles not being similar, and any attempt to make them alike would result, in many cases, in removing unnecessary metal. By boring wheels to suit axles, as will be explained later, the workmen on the lathes do not have use for calipers except for maximum or minimum sizes, which is somewhat novel for lathe work.

The question of turning all new axles to one exact size and returning repaired axles to snap gauges varying by 1/16 in. or 1/32 in. was carefully considered. A large number of axles which were calipered that had been turned apparently to uniform sizes showed quite a variation when measured by micrometers, in some cases as much as .010 inch. This would be too great for mounting in wheels all bored to one size. Better

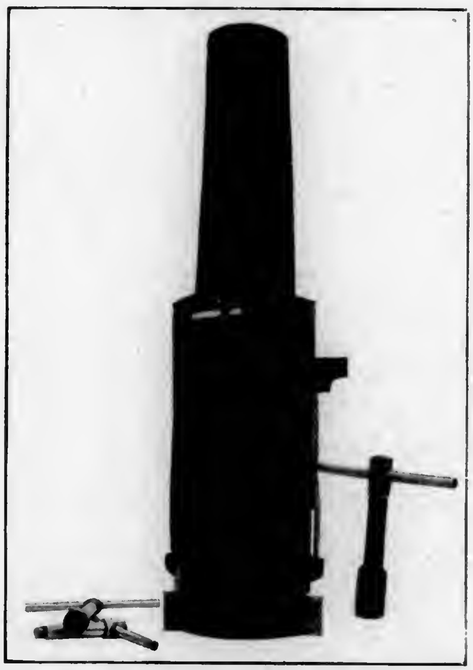


FIG. 3.—NEW DESIGN WHEEL BORING BAR.

work than this is, of course, possible, but is also expensive. Investigation brought out the fact that with proper boring bars wheels may be bored to varying sizes to suit axles cheaper than axles can be turned to suit the wheels. To accomplish this called for a boring bar that should be readily adjustable to varying sizes to suit different axles. These should have micrometer adjustment and index plate that shall readily indicate size of bore in thousandths of an inch, be quick to change from one size to another, adjustment to compensate for wear of cutties in order to obviate necessity of grinding them to very close measurements. Roughing cutters for first cut and finish cutters for finish or second cut, and all in one boring tool.

This refinement called for a design of boring bar new in some respects for wheel work. Figure 3 shows a bar that was designed by the writer to meet the above requirement. Other bars have been modified or designed of late, so that with proper selection there should be no difficulty in obtaining a satisfactory boring bar. A brief description of bar, Figure 3, may help to illustrate the points necessary for a satisfactory boring tool. The roughing cutters at the lower end are held by set screws and are only adjustable by loosening these screws. This is very satisfactory for large shops boring many wheels to near one size. However, for small shops where sizes are changed often, more ready means for adjustment is desirable. The finish cutters shown above the roughing cutters are adjusted as to size by a wrench turning a micrometer screw. On the micrometer screw there is a dial graduated into 100 divisions, each division equalling .001 inch in diameter of finish cutters. This number of divisions being chosen on account of allowing large spaces between divisions which may be easily read.

In case an adjustment over .100 inch is required, the micrometer screw is turned more than one turn. The index plate is held to the micrometer screw by two screws. By loosening these it can readily be revolved in reference to micrometer screw. This enables setting the index plate to indicate the size of bore, and to compensate for the wear of cutters. The finish cutters also have adjustment by which they may be adjusted true with the bore in wheel, this being desirable to avoid too close grinding of cutters, and also on account of ram of boring mill and table not always being in line. The finish cutters may be ground, one fully 1/16 in. longer than its mate or the bar may be 1/16 in. out of line and be compensated for in adjustment.

A few words about first-class wheel boring may not be out of place. Without a doubt, wheels should be bored having a true hole free from all ridges or roughness. Ridges in wheels are very objectionable on account of uneven strains on the wheel when mounting, making a leverage that may start a crack. On account of the eccentricity of the rough bore of steel wheels, and the core of cast iron wheels, there will always be some motion of the boring bar when boring, even with the most rigid construction. That is, the bar will follow the hole, also when the roughing cutters start to go out at the bottom of the hole the bar will vibrate less than when cutting higher up in the hole, which is apt to leave a ridge in the bore. If finish cutters are in use at the same time, they will make a ridge when roughing cutters are through the hole. The safe way to bore a wheel is to take a light finish cut independent of roughing cutters. This is a point well understood in machine work, but, strange to say, for wheel work the scheme of rough and finish boring all at one time is advocated, principally on account of greater output of machines, and while it is true that many wheels are bored very satisfactory by this plan, the method as a whole is undesirable, on account of stray wheels going into service having ridges in the bore. Actual trials on cast iron wheels showed that after rough boring it was necessary to enlarge the bore .040 inch to insure trueing the bore of all wheels.

To bore wheels to close sizes it is desirable to allow a predetermined amount of work for finish cut. This is to insure an equal amount of work for the cutters, and also uniform pressure on the various parts that will naturally have more or less give or lost motion. For cast iron wheels the finish cut can, with safety, be set at .040 inch, and for steel wheels about .020 inch. A practice followed with most excellent results with the bar, Figure 3, has been to set the roughing cutters to the smallest size bore required in ordinary limits; for instance when boring wheels 6⅞ in. to 7 in. they would be set 6⅞ in. As each wheel was rough bored the finish cutters were set .040 in. less than the size required, and the wheel was then bored with both sets of cutters in operation at one time. After this cut was completed, the bar being raised, the finish cutters were set out to the required size and the second cut taken when the finish cutters only were cutting. As an illustration of accuracy that may be attained, wheels were called for bored to following diameters: 6.982, 6.842, 6.928, 6.922, 6.940, 6.848, 6.809, 6.810, 6.822, 6.796 inches. All the wheels were bored in the order called for within a limit of .001 inch. No caliper readings were taken except to prove sizes after the wheels were removed from the mill. All changes in sizes were accomplished by turning the index wheel to the size called for, and the boring was done as fast as the cutting tools would permit. With a satisfactory boring bar having an acurate micrometer adjustment for finish cutters, wheels can be bored to any size required to accuracy of .001 in., and as many wheels turned out as by any method.

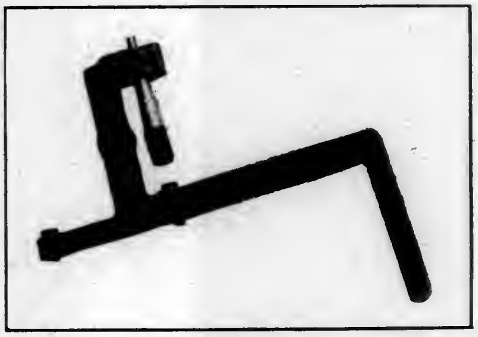


FIG. 4.—MICROMETER WHEEL BORE CALIPERS.

On account of this accurate wheel boring, which is an accomplished fact, it certainly is advisable to bore wheels to suit the axles on account of less cost for labor, and only turning the smallest possible amount from axles.

A satisfactory manner of setting finish cutters is as follows: A trial cut to be taken and calipered with micrometer calipers; the index can then be set to size shown by micrometer readings. Figure 4 illustrates a special micrometer caliper that was designed by the writer for wheel bore. The principal novelty is in the extra anvil to insure the caliper being set square with center line of wheel. Figure 5 shows an application of tubular inside micrometer caliper for same purpose. By either of these caliper readings may readily be made and size chalked on the wheel in 30 seconds.

The question of mating wheels to axles to obtain proper mounting pressure has always been and will continue to be a problem. Many theories were investigated where they appeared to have bearing on the subject. One of the old theories being that the hardness of wheel had everything to do with mounting pressure. There may have been some truth in this, but the writer was unable to discover it from advice of men several years in the business. Several trials were made with the workman's judgment of hard and soft wheels where it was claimed that the hardness would govern mounting pressure, also the draw or difference in axle and wheel diameter was carefully measured, and in no case could the general appearance of the wheel be taken as an indication of mounting pressure. Or, in other words, wheels made from the same run of metal will generally mount at about the same pressure when having the same draw, providing other conditions are similar. There are a number of conditions that will affect mounting pressure, even if apparent draw be similar. One is the kind of lubricant employed. A test with cast iron wheels showed that the mounting pressure would average about five tons higher using plain oil as compared with white lead and oil. Also the turning and calipering of axle has some bearing. If a tool is used that throws up a slight burr or fin, the calipers will read the top of this and not

the true solid metal which is liable to cause mounting at low pressure. The trouble of wheel or axle galling cannot in all cases be guarded against and may cause considerable variation in pressure, especially on steel wheels.

For accurate mounting of wheels to uniform pressure, no method of measurements and inspection has been devised to equal the micrometer method, and, with the calipers as explained above where the readings can be made quickly with but few possibilities of error, there should be no reason to continue the use of machinists' calipers.

One result will generally follow where micrometers are used, and careful inspection is insisted on. The wheel seat will be turned fairly true. With these conditions and draw, or mounting pressure, carefully checked, the wheel will have ample bearing on axle and will not work loose. A large number of measurements were taken to determine the proper draw or amount the axle should be larger than wheel. No general rule can be given for the amount of draw on account of wheel from various mills and foundries differing. However, by measuring the draw with micrometer and noting mounting pressure on a few wheels, the proper draw for any batch of wheels can be arrived at that will be a fairly true indication of mounting pressure.

A plan for mounting wheels on axles that has worked very satisfactory is as follows: Each axle when turned is calipered and the size of wheel seat chalked on the axle near wheel seat. From these sizes a list is made for the boring mill operator, deducting the necessary amount to be allowed for draw. The wheels are then bored and size chalked on the wheel after being proven by micrometers. The wheels and axles are then mounted, the sizes chalked giving necessary information as to which should go together. This plan avoids hunting among a lot of wheels and axles to find mated pairs and also the minimum amount of calipering.

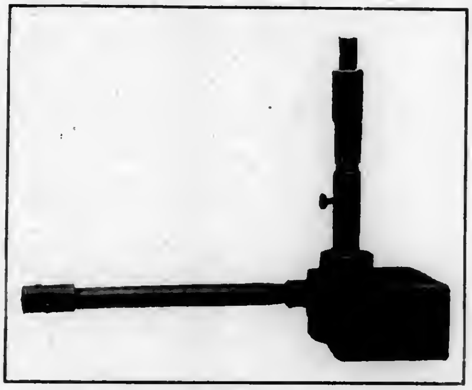


FIG. 5.—TUBULAR INSIDE MICROMETER.

The micrometers illustrated above have Brown & Sharpe micrometer heads, the frame having been made special on the railway where they are used, and to the best of the writer's knowledge have never been patented. The tubular inside micrometer caliper, Figure 5, was also made by Brown & Sharpe.

Recording gauges on mounting presses cannot be too strongly recommended, they being a check by which the superintendent can easily detect any bad or careless work. However, a recording gauge is not always a true indication of mounting pressure on account of the throw of the needle at each impulse of the pump. This is more noticeable with pumps having only one ram or piston. For accurate work or determined limits the average of the needle throw should be mostly considered.

The question of grinding in place of turning repaired axles is worthy of careful consideration. At first glance it may not look inviting on account of the apparent cost of machinery and possibility of costing more for labor than turning, but considering other phases, the question looks promising. Its advantages will be that a wheel seat once ground will not be injured enough in mounting and dismounting the wheel to require regrinding each time unless the wheel galls or scores the axle. That is, when compared to turning, the surface will be smoother and not have the many tool marks that generally push off when mounting the wheel. From experience with journals used in machinery we have every reason to believe that car journals would be ground better than the average of lathe turning and burnishing or filing. The sides of the collars and fillets being the most difficult parts. The makers of grinding machinery, however, say this is not a hard problem. By grinding the probabilities are that less metal will be cut away than by any turning method on repaired axles.

This should prolong their life. That is, when returning there is always a possibility of workmen cutting deeper than absolutely necessary in order to get below the glazed surface and insure removal of all low spots. With grinding there will be no incentive to cut deeper than absolutely necessary. Actual tests appear to indicate that by grinding only one-half as much metal will be removed as compared to turning; that is, where an axle may be reduced some .030 inch by turning, a similar axle will only be reduced some .015 inch by grinding and, as explained above, each .001 diameter costs about four cents, at which rate the value of axle would be reduced about 60 cents more by re-turning when compared with grinding.

INCREASED USE OF BLOCK SIGNALS

The Interstate Commerce Commission has issued a brief statement regarding the use of block signals on the railroads of the United States, on January 1, 1911, from which it appears that the total miles of railroad operated under the block system on that date was 71,269.1 miles, of which 17,711.5 miles was automatic and 53,557.6 was non-automatic. The increase in railroad mileage operated under the block system during the year 1910 was 5,511.1 miles; of this increase, 3,473.8 miles was automatic and 2,037.3 miles was non-automatic.

This bulletin includes thirteen steam roads which have not heretofore reported the use of the block system on their lines, and six electric trolley roads which were not included in the bulletins of previous years. In this bulletin four installations of automatic train stops are mentioned. These are on the Erie, the Hudson and Manhattan, the New York City terminal of the Pennsylvania Railroad, and the Washington Water Power Company's suburban lines.

A table showing the miles of road for each company reporting on which the telegraph and the telephone are used for transmission of train orders is also included in this bulletin. On January 1, 1911, the telegraph was used for this purpose on 175,211 miles and the telephone was used on 41,717 miles. This is an increase of 15,373 miles, on which the telephone was used, as compared with the figures for January 1, 1910.

The Largest Crane in the World.—The largest cantilever crane which has yet been erected has just been tested at the Imperial Japanese Navy Dockyard, Yokosuka. This crane, which was designed and constructed by Messrs. Cowans, Sheldon & Co., Limited, of Carlisle, is capable of dealing with a working load of 200 tons at a radius of 95 ft., and it was satisfactorily tested with a load of 250 tons at that radius. It is the largest crane that has up till now been built, but the same firm is at present erecting for the Japanese Navy, at Kure, one with a working power of 200 tons at 105 ft. radius, to be tested with a load of 250 tons. Hitherto the largest crane in existence has been the 160-ton cantilever crane, constructed by Messrs. Cowans, Sheldon & Co. for H. M. Dockyard, Devonport, and tested with a load of 240 tons at 95 ft. radius; that power being much greater than was obtainable by any crane previously built.

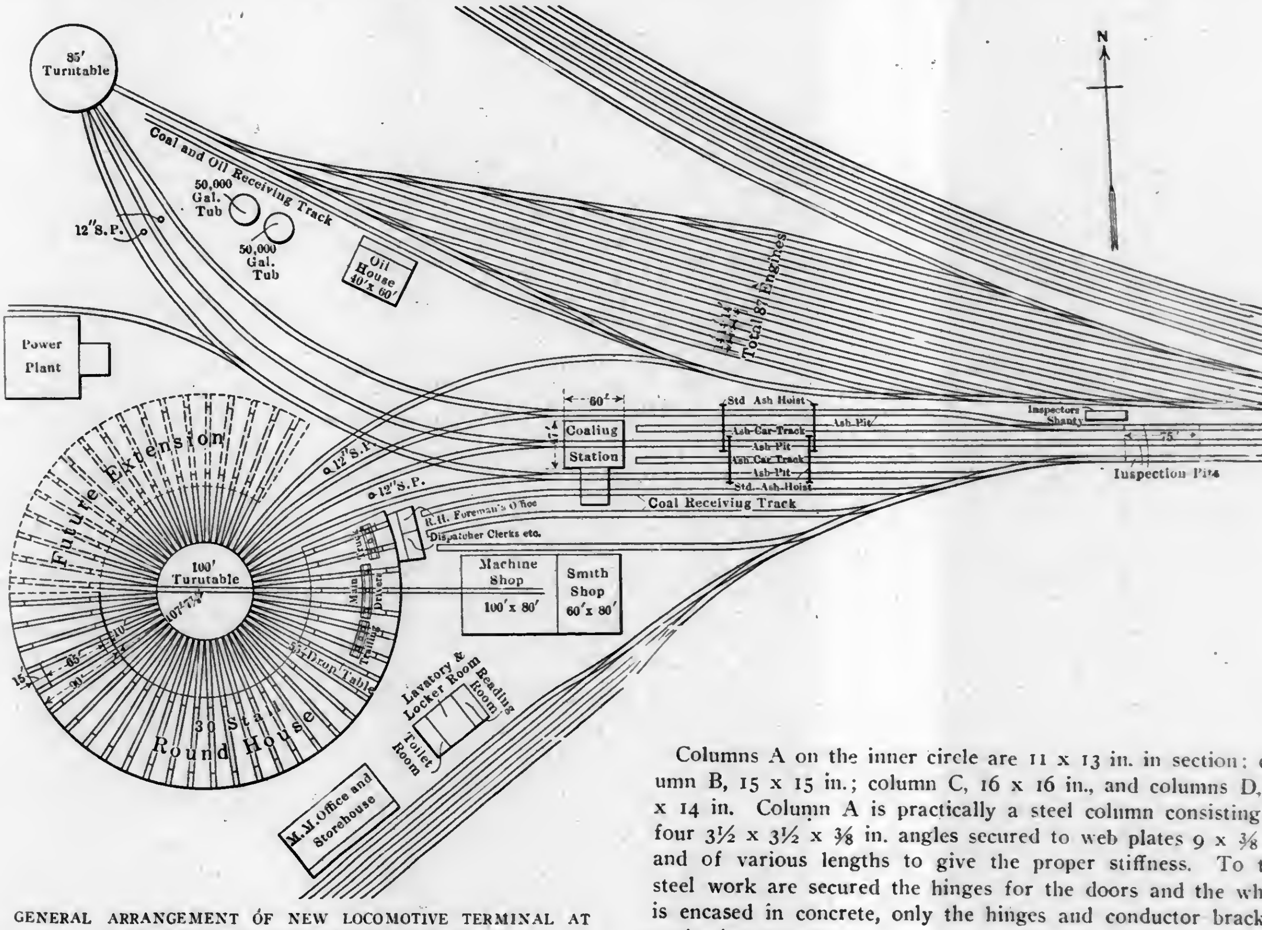
The Statistics Prepared by the American Iron and Steel Association show that the total rail production of all kinds in the United States in 1910 amounted to 3,634,029 tons, as compared with 3,023,845 tons in 1909.

Orangeville Locomotive Terminal.

PENNSYLVANIA RAILROAD.

A new locomotive terminal constructed by the Pennsylvania Railroad at Orangeville, near Baltimore, Md., which will take care of the power previously centered at Mt. Vernon, Biddle Street and Bay View, is notable for the very high character of the structures and the convenience of its arrangement. It includes a 30-stall reinforced concrete roundhouse, a large brick and steel machine and blacksmith shop, a commodious store house, fireproof oil house, a large power plant housed in a very attractive structure and a conveniently located, well arranged engineers' locker and reading room, as well as the usual coaling station, inspection pits, etc.

Referring to the illustration showing the general arrangement: The incoming locomotives enter from the left on a single track (not shown on the drawing), which separates into three incoming tracks before reacing the inspection pits. There is a 75-ft.



GENERAL ARRANGEMENT OF NEW LOCOMOTIVE TERMINAL AT ORANGEVILLE—PENNSYLVANIA RAILROAD.

inspection pit on each track, adjoined by an inspector's shanty, where the engineers' work reports are made out. These three tracks continue over the ash pits, which are the standard Pennsylvania type using an air hoist,* and under the coaling station, where the supply of sand is also obtained. At this point each track divides, permitting the locomotives either to go to the roundhouse turntable, if they are to be taken into the house, or to an 85-ft. turntable in the northwest corner of the property, which connects with the storage yard. There are standpipes for water supply serving all of these tracks. A single outgoing track leaves the roundhouse turntable and connects directly to a ladder forming the outgoing connection from all of the storage tracks. This track is served by a standpipe at the far end of the yard, but does not permit of taking coal or cleaning fires on the way out.

The illustration shows the general inter-relation of the building, and while at first it might seem that the oil house was not in a very convenient place, when it is remembered that many more locomotives pass though the storage yard than go to the roundhouse, it will be seen that this structure should be more convenient to that part of the terminal.

ROUNDHOUSE.

Structure.—This building has a solid reinforced concrete frame, each segment consisting of four columns, connected by girders, beams and slabs on the monolithic order.

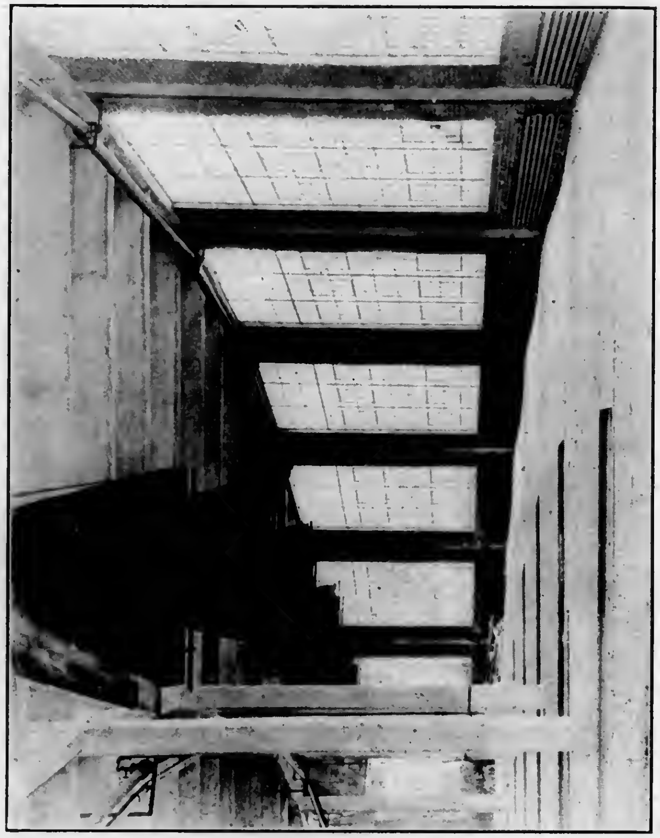
Columns A on the inner circle are 11 x 13 in. in section; column B, 15 x 15 in.; column C, 16 x 16 in., and columns D, 14 x 14 in. Column A is practically a steel column consisting of four 3½ x 3½ x ⅜ in. angles secured to web plates 9 x ⅜ in. and of various lengths to give the proper stiffness. To this steel work are secured the hinges for the doors and the whole is encased in concrete, only the hinges and conductor brackets projecting through.

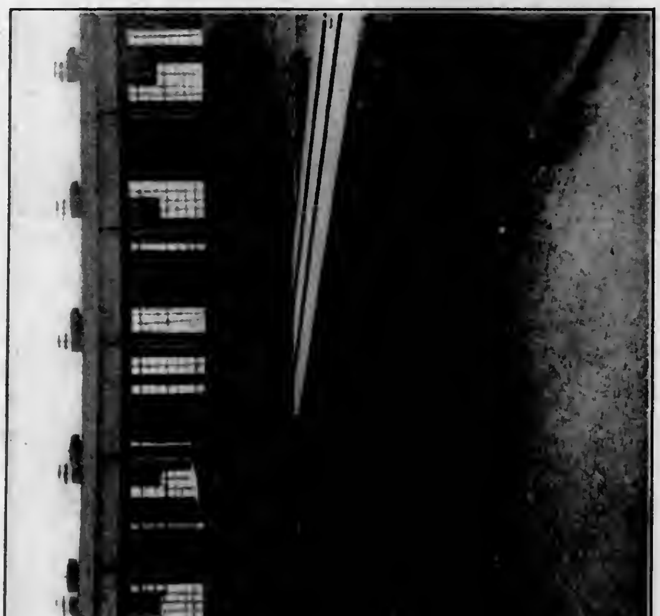
Between columns A is girder A reinforced on the bottom by two 6-in., 8-lb. channels riveted to the steel work of the columns. In addition there are other horizontal and vertical reinforcing rods to suitably form the eaves and gutter and to tie to the beams.

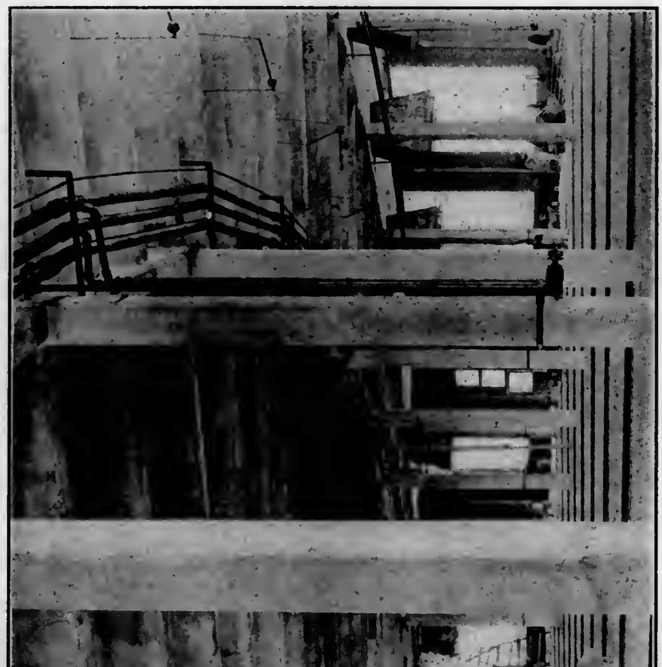
Columns B are reinforced by four ⅞-in. plain round rods, which are tied every 12 in. with ¼-in. wire ties. Columns B are connected at the top by girder B, which has a total depth of 2 ft. 10 in. and a width of 12 in., being reinforced on the bottom by five 1-in. square twisted rods, 3 being straight and 2 bent up at the ends.

Between girder A and girder B there are three beams, two coming at the posts and one in the center, which have a total

* For detailed description see AMERICAN ENGINEER, Feb., 1906, page 47.







GENERAL INTERIOR AND EXTERIOR VIEWS OF ORANGEVILLE LOCOMOTIVE TERMINAL.

depth of 2 ft. 4 in. and a width of 9 in. These are reinforced by three 1¼-in. square twisted rods, two straight and one bent up at the ends, together with the stirrups of ⅜-in. round iron.

Columns C are connected by girder C, which is the same as girder B in section, but has five 1¼-in. square twisted rods for reinforcing. Between girders C and B there are four beams, two at the posts and two spaced midway between, having a section the same as between A and B, but having four 1-in. square twisted rods, two of which are bent up at the ends, in place of three 1¼-in. rods.

Between columns D is girder D, which is 2 ft. 10 in. in depth and 12 in. in width and is reinforced with four 1-in. square twisted rods, two bent up at the ends and other reinforcing to form the eaves and gutter. Between girders C and D the same beams as between B and C are continued.

It will be noticed that the span between girders C and D is shorter than between C and B, which in turn is shorter than between A and B, which accounts for the use of similar concrete beams, although the roof area supported continuously increases.

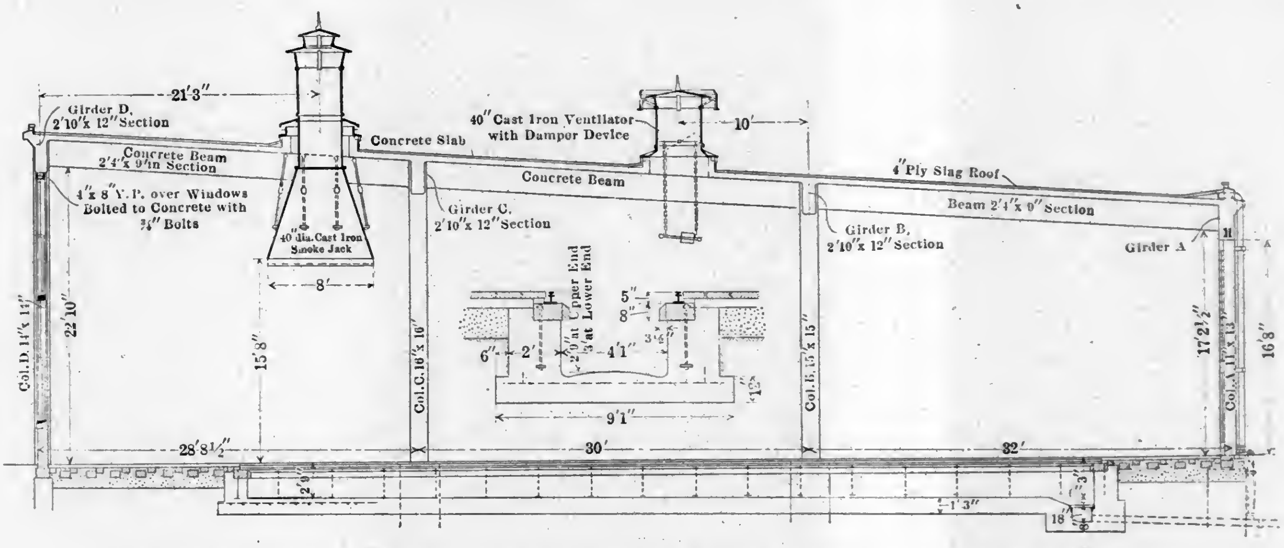
The roof structure is concrete slabs 4½ in. thick reinforced by ⅜-in. plain round rods spaced 6-in. centers across the beams and by ⅜-in. shrinkage rods at about 18-in. centers parallel with the beams. Other reinforcing is installed at the connection with the various girders and beams. These slabs are covered with four-ply slag roofing. The openings for the smoke jacks and ventilators are formed in the slabs and eyebolts for carrying the jacks are embedded in the concrete.

The outer wall of the house is formed by a 9-inch brick filling between columns D and below girder D. This filling is not tied to the concrete work and extends to foundation at the ground level. A large part of the space, however, is taken up by window area, steel frames and sash being employed, which extend from the concrete girder to about 3 ft. 6 in. from the ground level where blue stone sills, resting on the brickwork, are located. These windows occupy a space 16 ft. 9½ in. in width, the distance between centers of columns being 23 ft. 11 7/16 in.

The floor consists of 3 x 12-in. plank laid radially, parallel with the pits, on 4 x 6-in. pine sleepers imbedded in 18 in. of cinders. The floor at the center between pits is 4 in. higher than the rail. The doors are of the usual swinging type and are arranged to swing inward. They are carried from hinges imbedded in the concrete columns and give an opening of about 12 ft. Every third pit is provided with a wicket door. The end walls are of brick filling between concrete columns and provided with narrow windows in each panel.

Pits.—The pits are of most substantial solid concrete construction, reinforcing rods being used wherever the character of the ground made it necessary. The side walls throughout are 2 ft. in width and the foundation is at least 12 in. thick at the narrowest point and is 9 ft. 1 in. in width, except at the jacking walls, where the width of the side walls is carried out to 3 ft. 6 in. and the width of the foundation to 12 ft. 1 in. These extensions for jack foundations are 8 ft. in length and located at the outer end of each pit on either side and at a point 27 ft. from the outer end of the pit. The bottom of the pit is well crowned and has a slope of 3 in. in its length of 65 ft. inside, draining toward the inner circle. Here there is a cast iron grating over a sump, which connects with a 4-in. cast iron pipe leading to the turntable pit. The rails are carried on 8 x 12-in. stringers bolted to the top of the concrete wall, as is shown in the cross section. A 3 x 8-in. oak strip with the upper edge beveled is spiked inside of the stringer, acting as a protection for the heating pipes, which are secured along the inside wall of the pits. The roundhouse floor is carried directly up to the rail on either side.

Eight pits in the end of the house adjacent to the machine shop are provided with drop pits. The first two tracks having a drop pit for truck wheels, the next three a drop pit for drivers and the following two a drop pit for trailing wheels. The next pit is provided with a 55-ft. drop table for dropping all wheels on the locomotive at once.* These drop pits are built with the same general style of walls and floor as are used in the regular engine pits.

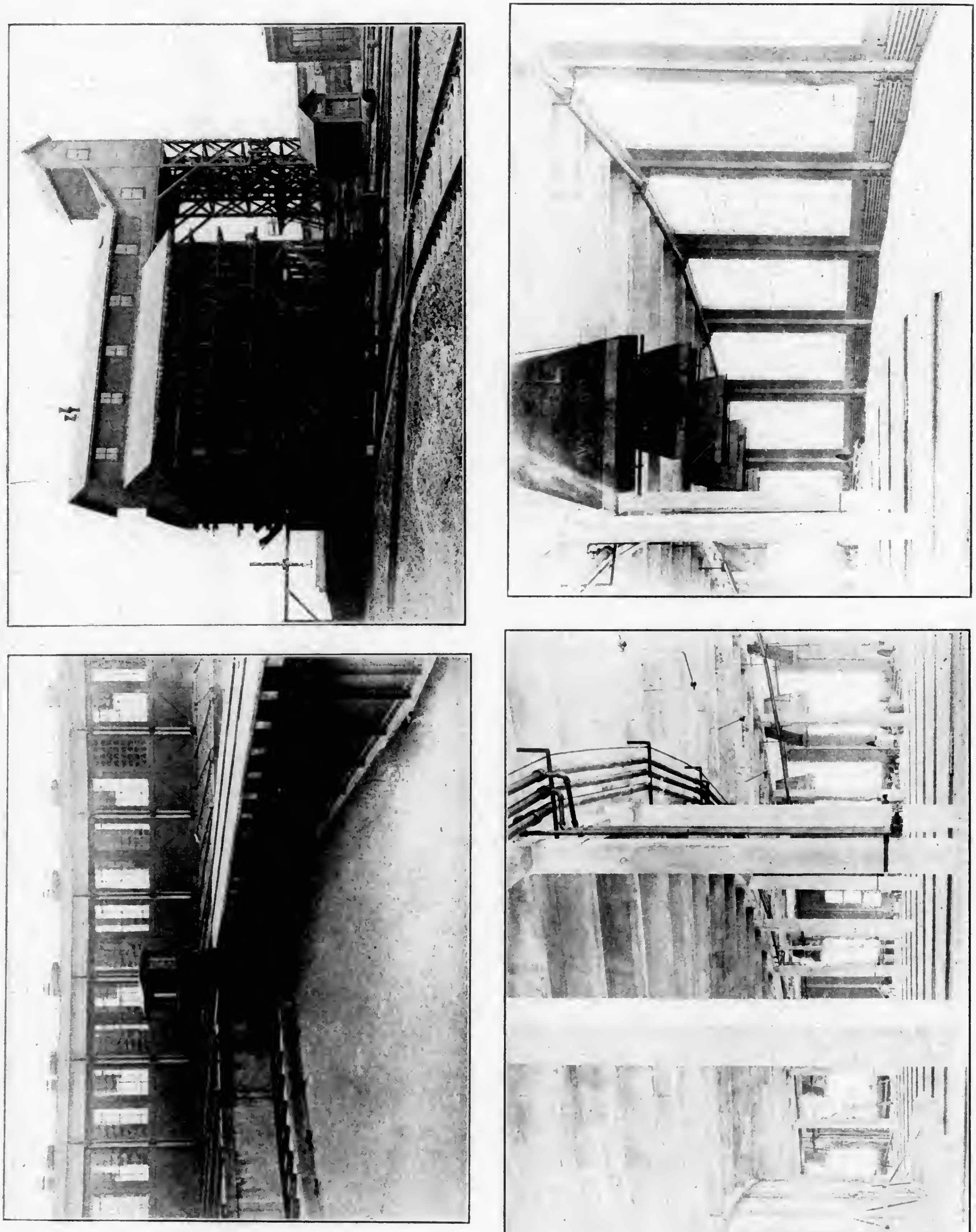


SECTION OF REINFORCED CONCRETE ROUNDHOUSE ERECTED BY THE PENNSYLVANIA RAILROAD AT ORANGEVILLE.

Cast iron smoke jacks, of a new design recently developed by Paul Dickinson, Inc., are used. These jacks have a length of 8 ft. and are supported from the I-bolts imbedded in the concrete roof slabs. The hood of the jack joins a 40-in. diameter circular section made in two parts, which passes through an opening 4 ft. 6 in. square in the roof slab, provided with a heavy 8-in. concrete curb for distributing the stresses to the adjacent beams. The space between the jack and the roof is covered, but not closed, with a cast iron extension forming part of the jack, space being left for ventilation at this point. The top of the jack has a double hood for protection from rain or snow. In addition to the space around the smoke jacks for ventilation there is also provided a ventilator at about the center over each pit. These ventilators have dampers controlled by a sliding weight on the end of a chain operating gear. Their construction and arrangement is shown in one of the illustrations.

Lighting.—Inasmuch as this type of house is not provided with any overhead natural lighting, as has been customary in most new houses, special attention was given to providing large natural lighting area at both ends of the pit, and in this respect, as is clearly shown in the illustrations, unusual success has been obtained. The windows in the outer circle are about

* For illustrated description of this type of table see AMERICAN ENGINEER, March, 1906, page 84.



GENERAL INTERIOR AND EXTERIOR VIEWS OF ORANGEVILLE LOCOMOTIVE TERMINAL

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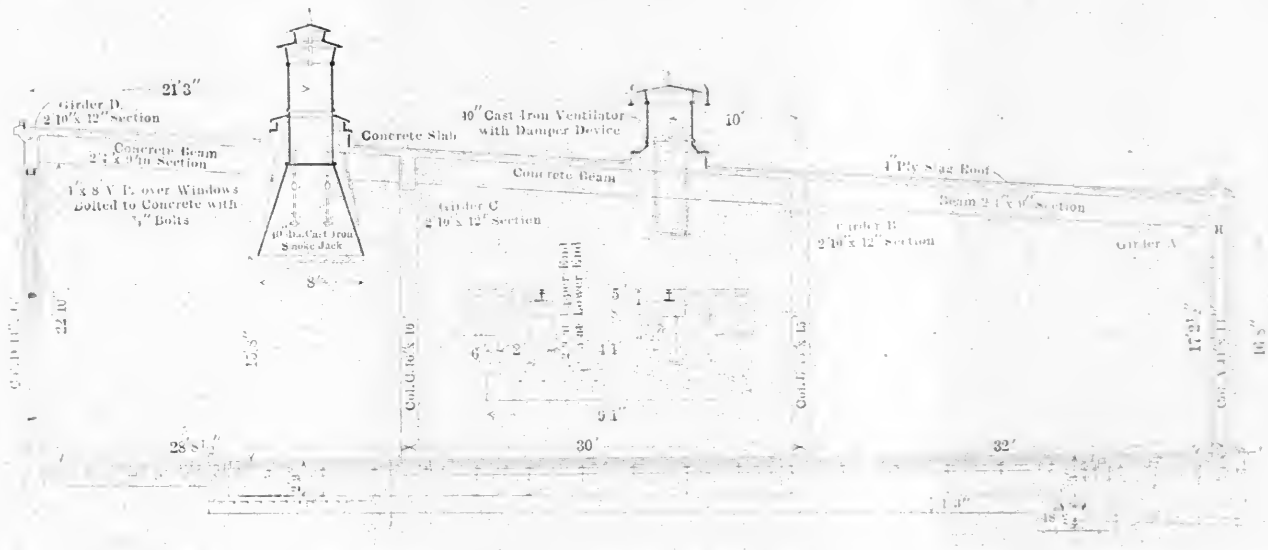

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* For illustrated description of this type of table see American Engineer, March, 1906, page 81.

16 ft. 9½ in. in width and 18 ft. 10 in. high over the frames; a steel sash known as Detroit Fenestra, manufactured by the Detroit Steel Products Co., is used. For large areas of this kind this type of sash has many advantages, not only in its strength, but also in greatly increasing the available lighting area. In each of the large windows there are six sections arranged to swing on the horizontal axis and provided with controlling rods for holding in any desired position. On the inner circle the swinging doors have large sash in each. This gives altogether about 375 sq. ft. of natural lighting area per pit, not including the windows in the end wall.

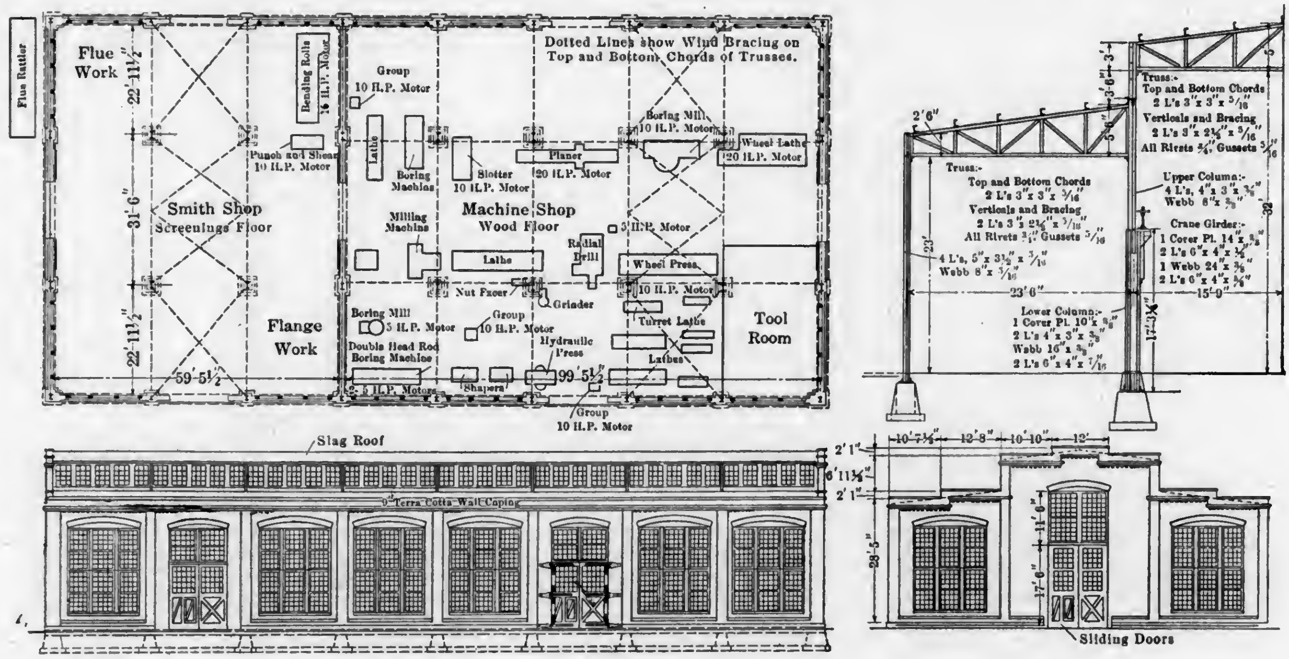
The heating system is by direct radiation and includes four large pipes running the full length on either side of each pit and a coil consisting of six sections extending the full length between concrete columns under the windows in the outer circle. This heating system was designed and installed by the National Boiler Washing Co., who also furnished the boiler washing equipment.* The three pipes used in the boiler washing and filling system are supported by brackets secured to the concrete beams along the inside of column B, the connections coming down at every alternate post, arranged as is shown in one of the illustrations. Similar brackets carry the high pressure steam and air lines along the top of column C, while the same supply for the heating system is carried in a large pipe at the top of columns D. The exhaust lines for the heating system are carried in a conduit just inside the foundation of the outer circle, this being covered with removable sections of flooring.

The boiler washing tanks and pumps and other apparatus are located in the power house and pipes are carried to the roundhouse in an elevated wooden trough supported by steel bents. This same elevated conduit also carries the steam heating lines and other pipe lines from the power house.

Turntable.—The turntable pit has concrete side walls and a concrete ledge for supporting the circular rail and is floored with brick paving. The table is a 100-ft. standard Pennsylvania type and is propelled by the standard electric turntable tractor of George B. Nichols & Bro., which operates the turntable with the heaviest locomotive at a rate of 60 degs. in 60 seconds. This tractor is simply an attachment to the table and is entirely self-contained. It is driven by a 22-h.p., three-phase, 220-volt motor. The cab is on the tractor frame and all controlling appliances are located therein. A similar tractor is used on the 85-ft. turntable at the end of the storage yard. Since this latter turntable is located on the property line and has entering tracks from but one side, the concrete circular wall has been carried up about 3 ft. above the surface on the far side to act as a bumping post and prevent the locomotives running off the end of the table.

Shop Building.

A steel and brick structure 80 ft. 3 in. x 162 ft. 10 in. outside dimensions, houses the machine and blacksmith shop, the two shops being separated by a brick wall. This structure consists of three bays, the center one being carried up to give a row of windows on either side. There is a 10-ton crane over the center bay of the machine shop. The structural details and architectural appearance are clearly shown in the illustration, as are also the arrangement and list of machine tool equipment. The same careful attention to natural lighting found in the roundhouse is also apparent here. The side windows have wooden sash and are balanced one with the other, while the windows in the clere-story are provided with an operating gear, so they can be controlled from the floor level. The total natural lighting area of the building in square feet is almost exactly equal to the floor area.



MACHINE AND BLACKSMITH SHOP AT ORANGEVILLE.

An inspection of the tools provided will show that this shop is prepared to make any class of repairs on its locomotives if necessary. The heavier tools are all grouped under the crane and are largely driven by individual motors, while the smaller tools are in most cases group driven. One of the tracks in the roundhouse served by the driver drop pit continues through the outside wall and for the full length of the machine shop. This permits the loading and unloading of heavy parts by means of the crane and also allows a locomotive to be drawn into the shop and the crane used for dismantling.

The shop is heated throughout by direct radiation, with the coils under the windows on the side walls. The roof is of four-ply slag roofing laid on ¾-in. sheathing.

Power House.—A structure which far exceeds in its architectural beauty anything usually associated with a locomotive terminal, encloses the power house at Orangeville. It consists of a practically square building of brick with granite footings and terra cotta trimmings, with a steel stack without stays located in almost the exact center. An extension on the rear of 31 ft. 9½ in. by 34 ft. 7 in. outside is provided for the boiler wash-

* For full description of this washout system see American Engineer, Dec., 1910, page 469.

ticularly striking, but so far it is not clear that the claims made by the champions of this system can be entirely substantiated under railroad conditions. There seems to be but little doubt that the continued improvement in shop methods will be along the lines of scientific management, the same as they would have been irrespective of the recent general publicity given to the subject. This agitation may hasten the development along these lines in some cases, but it is hoped that it will not hasten it beyond a natural pace or to the defeat of the ultimate benefits which can be obtained if properly handled. Scientific management can be installed in manufacturing plants in many cases, but experience indicates that it must develop in the railroad shop. This development can be hastened, but must not be forced.

THE IMPORTANCE OF CENTRAL CONTROL IN MACHINE TOOL DESIGN

The high development of the modern machine tool necessarily imposes complication in varying degrees, but despite this feature the fact remains strikingly prominent that ease of control is present to a marked degree in practically all of them. Many examples of foreign built machine tools exhibit a very poor conception of the importance which should be associated with centralized control, but it is a point which has apparently been accorded the full measure of recognition and consideration by American designers.

That this is as it should be requires no comment. An operator should not be compelled to walk around even a large machine once in the day's run, except possibly to oil it, and this latter is now being provided for by automatic and continuous systems of lubrication. A machine tool in addition to being rigid and powerful must be handy. It is the means to an end which is not simply the removal of so many pounds of cuttings per hour, but it is the production of a finished article in the shortest possible time. The "handiness" of a machine is relatively of more importance now when using high speed machines than in the days of carbon steel. It is a feature not difficult to secure in the instance of the smaller tools, but in large slotting, milling and planing machines many problems need to be solved before all of the levers and stops can be placed directly in reach of the operator.

Too much importance cannot be given to the necessity of grouping the various handles and levers which control or produce the different motions, of the means for effecting quick changes of speed, direction and changing of feed; in fact, anything which will conduce to ease in manipulation and the saving of time. It is in these features especially that the American tools excel, and the successful tools of the future will undoubtedly be those where handiness is combined with the necessary elements of stability, strength and power.

MANUFACTURING BY RAILROADS

The discussion of the railway as a manufacturer, which was featured last month during the annual convention of the Railway Storekeepers' Association, revives a question which is in reality as far now from solution as it was when first propounded. We know little more in regard to the desirability of making things ordinarily purchased than we ever did, and the prominent plants where this procedure is resorted to are quite reticent in the production of statistics attesting to its value.

The two most prominent illustrations probably in the world of wholesale manufacture by railroads may be found in the instance of the Crewe shops of the London and North-Western Railway, and those of the Philadelphia and Reading, at Reading, Pa. In the former anything used by any department of the railroad, from rails to flags, soap and writing paper, is turned out on the premises. The Reading is less ambitious in scope, but may well be likened as the nearest American counterpart. Those who advocate this procedure from an economical standpoint frequently refer to Crewe in support of their arguments, but obviously without full information of its existing conditions. Economy is not the particular consideration, and it is not a claim of the London and North-Western that any is secured by this production of ordinarily purchased items.

These shops are very old, practically the oldest in England. They were in existence long before the present development in outside manufacturing plants had been attained, and it was necessary that they should provide for their own needs. For instance, in the comparatively recent period which marked the introduction of the steel casting, the supply was not forthcoming, hence the addition to Crewe of a steel foundry. The entire situation is merely an illustration of growth or expansion imposed by certain conditions, and now that the latter no longer exist it is freely admitted by mechanical engineers in England that the London and North-Western cost of production is higher than the terms of the business concerns from which they would buy, in the case of a very large number of articles. The fact is also, of course, apparent that the company is denied the advantages of competition which would ensue to a certain extent if they became buyers in the open market. Crewe is a poor illustration of an advantageous railroad manufacturing scheme. There is no good reason why it should go on making things simply because it started to do so years ago.

The real facts in connection with the latter as relates to our own roads are that the experiences of those who have attempted manufacturing have been widely diversified. It is recalled that the Baltimore and Ohio about ten years ago installed a complete spring plant in its Mt. Clare shop in Baltimore, with very indifferent results, while on the other hand the Chicago and Northwestern, for instance, makes and repairs all springs for the 1,700 locomotives on the system. There does not seem to be much to be learned from such contrasts, and the above is only an illustration of innumerable instances.

A careful review of the past few years would seemingly indicate that the large majority of railroads are decidedly favoring the purchase of material. It is fully realized that they cannot compete with the progressive ideas and equipment of the regular manufacturers. The manufacturing field, divided as it is, concentrates its business and employs experts, not only as foremen, but also as workmen. The manufacturer must pay attention to all lines of economy, this being demanded by competition which will eliminate him if he does not do so. It is much easier for a railroad shop to drop back or stand still in the manufacturing field than for the manufacturer who is spurred on by competition or necessity. All railroads have specifications covering given lines of material and it is easier to compel a manufacturer to live up to these than for the railroad to compel its own men to do so.

In regard to the manufacturing of such articles as tinware, piston packing, locomotive springs, crank pins, etc., it is generally conceded by railroad officials that the railroad shop cannot compete with the concerns who make a specialty of manufacturing such materials. This may be readily explained through the presence in these manufacturing plants of highly developed special machines and appliances which are operated by much less highly compensated labor than that employed by railroads for similar work.

On the other hand, conditions undoubtedly arise on railroads from time to time when the question of manufacture needs to be accorded serious consideration. During a period of depression, known to be temporary, manufacturing may be very sensibly resorted to, even at a loss, in order to prevent the dissolution or weakening of a well balanced, smooth working shop organization.

It would appear, however, that practical economy is better secured through purchasing, and only such miscellaneous material of which no great amount is required should be manufactured. The general subject is very broad and significant, and it is well worthy of the attention which it now receives.

Test of Mallet Locomotives

NORFOLK AND WESTERN RAILWAY.

THE VERY CAREFUL AND ACCURATE COMPARATIVE ROAD TESTS RECENTLY MADE ON TWO DISTINCTLY DIFFERENT ARRANGEMENTS OF THE SAME POWER LOCOMOTIVES AFFORD SOME VERY INTERESTING AND VALUABLE INFORMATION IN CONNECTION WITH THE FEATURES OF DESIGN OF THIS COMPARATIVELY UNFAMILIAR TYPE

In May and June, 1910, there were received by the Norfolk & Western Railway Company five Mallet compound locomotives of the 2-8-8-2 type, which were given the class designation of Y1, and five similar locomotives of the 0-8-8-0 type, which were given the class designation of X1.* These two designs of locomotives, while differing in many of the features, have the same sized cylinders, the same steam pressure, the same diameter of driving wheels, and in fact were both designed to deliver the same power under the same conditions.

Shortly after they were received arrangements were made for conducting a thorough comparative test and for this purpose the Westinghouse Air Brake Company's dynamometer car No. 5 was procured and used. These tests were carried out with the greatest care and accuracy, as will be seen by referring to the methods used, which are described at the end of this article, and the results obtained are most important in indicating the feature of advantage found in both designs.

As a general summary of the conclusions it is stated in a report to the superintendent of motive power:

"Engine No. 998 (2-8-8-2 type) gives a better boiler performance up to the time the steam passes from the high pressure cylinders, where there is evidence of a considerable drop in steam pressure from the high pressure steam exhaust to the low pressure steam delivery. This drop in pressure is remarkably in excess of that observed on engine No. 993 (0-8-8-0 type). As to engine performance we find that engine No. 993 handled 9.8 per cent. more cars and 3.6 per cent. more tonnage at an increase of 19 per cent. in speed. The consumption of coal per thousand ton miles on the two engines was very close, with a slight difference in favor of engine No. 993. The indicated and draw bar horse power, as well as the per cent. of draw bar to indicated horse power were all singularly favorable to engine No. 993. We can draw no other conclusion from this data than that engine No. 993 (0-8-8-0 type) shows the better performance of the two types of Mallet compounds."

The following table gives the general dimensions, weights and ratios of the two locomotives tested:

GENERAL DATA.

Locomotive	998	993
Fuel	Bit. coal	Bit. coal
Tractive effort	77,000 lbs.	85,000 lbs.
Weight in working order	390,000 lbs.	375,000 lbs.
Weight on drivers	360,000 lbs.	375,000 lbs.
Weight on leading truck, est	15,000 lbs.	———
Weight on trailing truck, est	15,000 lbs.	———
Wt. of engine and tender in working order	560,000 lbs.	433,600 lbs.
Wheel base, total	55 ft. 6 in.	41 ft. 2 in.
Wheel base, engine and tender	83 ft. 3 in.	72 ft. 10 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.67	4.42
Total weight ÷ tractive effort	5.06	4.42
Tractive effort × diam. drivers ÷ heating surface	730.00	887.00
Total heating surface ÷ grate area	78.50	71.00
Firebox heating surface ÷ total heating surface, %	3.55	3.95
Weight on drivers ÷ total heating surface	61.00	69.70
Total weight ÷ total heating surface	66.00	69.70
Volume both cylinders, cu. ft	25.50	25.50
Total heating surface ÷ vol. cylinders	233.00	210.00
Grate area ÷ vol. cylinders	2.96	2.96
CYLINDERS.		
Kind	Compound	Mellin Compound
Diameter	24½ and 39 in.	24½ and 39 in.
Stroke	30 in.	30 in.
VALVES.		
Kind	Piston	Piston
Diameter	15 in.	14 in.
Lead	¼ in.	3/16 in.
WHEELS.		
Driving, diameter over tires	56 in.	56 in.
Driving, thickness of tires	3 in.	3 in.
Driving journals, main, diameter and length	10 x 12 in.	10 x 12 in.
Driving journals, others, diam. and length	9½ x 12 in.	9½ x 12 in.
Engine truck wheels, diameter	30 in.	———
Engine truck, journals	6 x 10 in.	———
Trailing truck wheels, diameter	30 in.	———
Trailing truck, journals	6 x 10 in.	———
BOILER.		
Style	Straight	Straight
Working pressure	200 lbs.	200 lbs.
Nozzle, diameter	7 in. ¾ in. Br'd'g.	6 in. ⅜ in. Br'd'g
Outside diameter of first ring	80 in.	83⅞ in.
Firebox, length and width	120⅛ x 90¼ in.	120⅛ x 98¼ in.
Firebox plates, thickness	⅜ and ½ in.	⅜ & ½ in.
Firebox, water space	F. 5½, S. & B. 5 in.	F. 5½ in. S. & B. 5 in.
Tubes, number and outside diameter	350—2¼ in.	367—2¼ in.
Tubes, length	21 ft.	24 ft.
Heating surface, tubes	4,309 sq. ft.	5,167 sq. ft.
Heating surface, firebox	210 sq. ft.	212 sq. ft.
Heating surface, feedwater heater	1,389 sq. ft.	———
Heating surface, total	5,908 sq. ft.	5,379 sq. ft.
Reheater heating surface	586 sq. ft.	———
Grate area	75.2 sq. ft.	75.3 sq. ft.
TENDER.		
Water capacity	9,000 gals.	9,000 gals.
Coal capacity	14 tons	14 tons

In the following table is given a summary of the average results of six trips on each locomotive, showing the percentage in favor of either design:

SUMMARY OF AVERAGE RESULTS.

	No. 998.	No. 993.	Per cent. in favor of 998.	Per cent. in favor of 993.
Boiler pressure pounds per sq. in.	191.3	193.2		
Water supplied goiler, pounds	108,450.0	97,582.0		
Coal total, pounds	12,617.0	12,467.0		
Ratio total water to total coal	8.66	7.83	11.0	
Equivalent evaporation per sq. ft. heating surface per hour	8.42	9.70		15.2
Equivalent evaporation per pound of coal.	10.46	9.49	10.0	
Coal per sq. ft. of grate area per hr.	61.20	72.40		18.
Moisture in steam high pressure (per cent.).	.94	.83		13.2
Moisture in steam low pressure (per cent.).	1.10	2.02	83.7	
Draft in front end of smoke box (in. of water).	6.1	7.2		18.
Temperature of escaping gases F. deg.	376.1	514.2	37.0	
Drop in steam press. between high and low press. cyl's (L. side)	9.2	4.9		46.9
Boiler horsepower	1,439.0	1,515.0		5.2
Boiler efficiency, general	77.1	64.9	18.8	
Distance of run miles per trip	29.5	29.7		
No. of cars in train, average per trip	20.5	22.5		9.8
Tonnage of train, average per trip	1,458.7	1,511.6		3.6
Engine performance, speed miles per hour	11.0	13.1		19.0
Pounds of coal per M ton miles excel. delays and ewight of engine and tender	278.1	273.7		1.6
Indicated horsepower.	1,397.7	1,604.3		14.8
Draw bar horsepower	1,093.7	1,347.0		23.2
Per cent. of draw bar to indicated horsepower	78.2	83.9		7.2

A study of the complete data given below indicates the following features in connection with various parts of the test:

General Performance.—Engine No. 993 shows 15 per cent. reduction in running time, with a 19 per cent. increase in speed, hauling 9.8 per cent. more cars and 3.6 per cent. more tonnage, with a reduction of 1.6 per cent. in coal per thousand ton-miles.

Draft and Temperature of Gases.—The average smoke box vacuum on engine No. 993 is greater by 18 per cent., resulting from a smaller nozzle. There is also an increase in coal consumption per square foot of grate area per hour of 18 per cent. on this locomotive. The presence of the feed water heater and re-heater tubes in engine No. 998 have a marked effect upon the temperature of the escaping gases, there being a differnce of 37 per cent. in favor of engine No. 998 on this account.

The Value of Steam Re-Heater.—The temperatures of steam before and after entering the re-heater on engine No. 998 did not indicate any marked advantage in this arrangement, as the temperature was lower than it was before passing through the re-heater. The drop in temperature is no doubt due to the increased volume of the heater and the steam entering was accompanied by a drop in pressure and temperature. That the re-heater has a drying influence on the steam is indicated by the low percentage of moisture in the steam delivered to the low-pressure cylinder of engine No. 998.

Equivalent Evaporation.—The equivalent evaporation per pound of coal shows up well for both engines, and while the results appear high at first glance, it must be remembered that these are very large boilers and the low temperature of escaping gases would indicate a very high evaporative efficiency When compared with the results obtained on the testing plant at St. Louis it will be seen that these figures are not excessive.

* For fully illustrated description of these locomotives see the AMERICAN ENGINEER as follows:
Class Y1, July, 1910, page 269.
Class X1, September, 1910, page 341.

Pressures from Indicator Cards.—Referring to the initial pressures on the low-pressure cylinders with the least back pressure of the high-pressure cylinders, it will be seen that the left low-pressure cylinder of engine No. 998 gives an average of 53.6, while the least back pressure on the left high-pressure cylinders is 62.65, showing a drop of 9.2 lbs. between the high and low-pressure cylinders. The same figures on engine No. 993 show a drop of 4.9 lbs. between the high and low-pressure cylinders, or 46.7 per cent. less. This difference is doubtless due to the friction and increased volume of the numerous passages through the re-heater on engine No. 998.

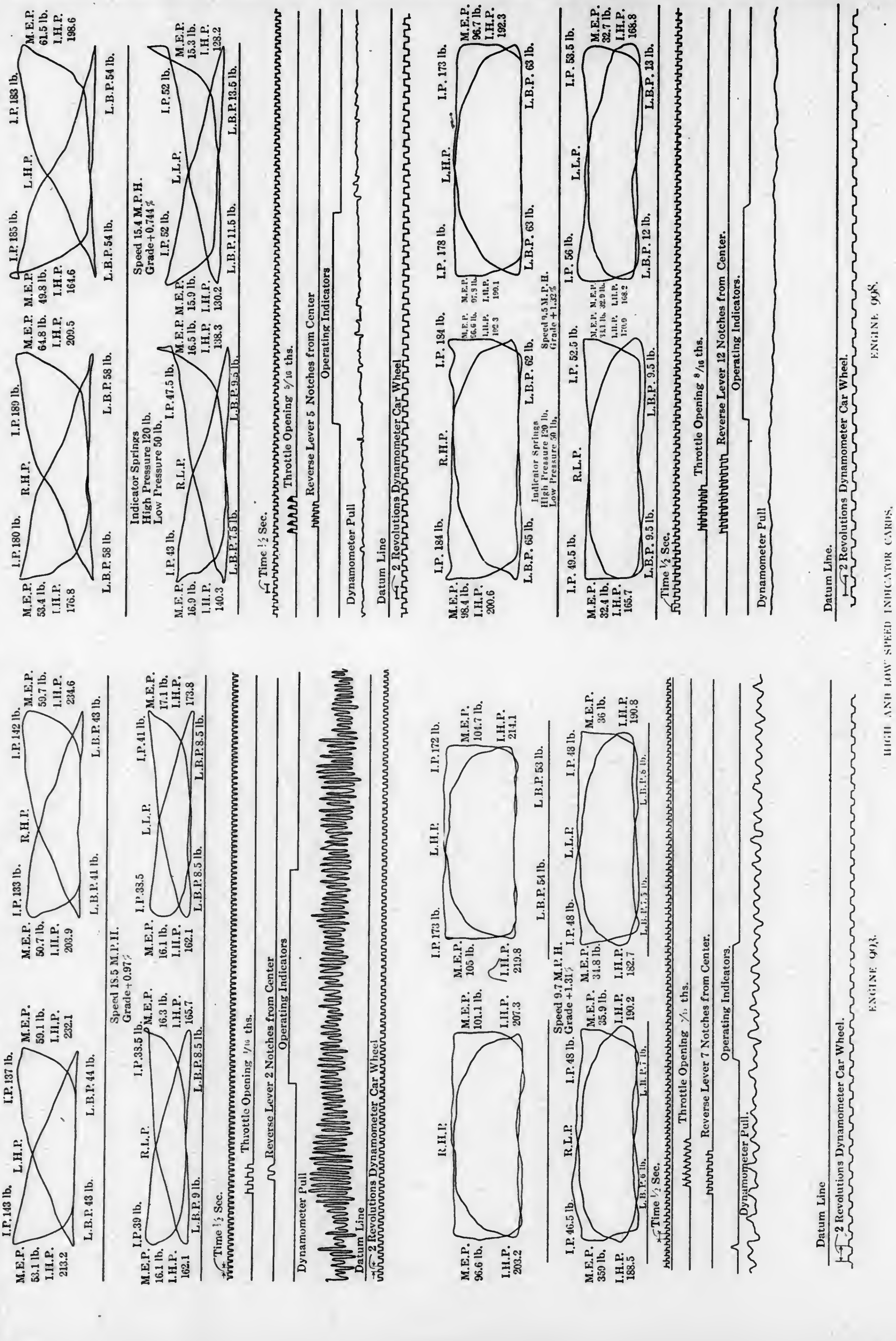
Horse Power.—Engine No. 998 gave an average indicated horse power of 1,397.7, with a corresponding draw bar horse power of 1,093.7, or 78.2 per cent. Engine No. 993 gave 1,604.3 indicated horse power and a draw bar horse power of 1,347.7, or 83.9 per cent. In indicated horse power, No. 993 was greater by 14.8 per cent. and in draw bar horse power this engine was 23.2 per cent. greater. The boiler horse power of No. 998 is slightly lower than No. 993, but its efficiency is 18.8 per cent. greater.

High and Low Speed Conditions.—On the section of the road from Roanoke to Elliston engine No. 998 gave an average speed of 15.1 miles per hour and No. 993 18.2 miles per hour. Under these conditions engine No. 998 gave a draw bar horse power equivalent to 72.2 per cent. of the indicated horse power, while No. 993 gave 79 per cent. of the indicated horse power, a difference in its favor of 6.8 per cent. The detailed record shows that Engine No. 993 gave an average minimum speed which very closely approached the average maximum of 998, while at the same time it was handling 9.8 per cent. more cars and 3.6 per cent. more tonnage.

On the section of the road from Elliston to Christiansburg there is a steady pull up a 1.32 per cent. grade for a distance of approximately 12 miles. The average speed of No. 998 with these conditions was 8.3 miles per hour, while No. 993 gave 9.4 miles per hour. In this service No. 998 gave a draw bar horse power of 80.7 per cent. of the indicated and No. 993 gave 85.5 per cent. of the indicated horse power, a difference of 4.8 per cent. greater, which shows that engine No. 998 more nearly approaches the performance of No. 993 when working under slow speed and heavy tonnage conditions.

In the following table giving the full data of the tests, each result is the average of six trips:

GENERAL PERFORMANCE.		
Engine No.	998	993
Type	2-8-8-2	0-8-8-0
Duration of Test, Hours:		
Total	3.663	3.146
Delay	.996	.88
Running	2.667	2.266
Miles run	29.5	29.74
Speed M. P. H.	11.06	13.12
Train tonnage	1,458.7	1,511.6
Number cars	20.5	22.5
Thousand ton miles	43.046	44.955
Pounds of coal per thousand ton miles	278.1	273.7
FUEL, RATE OF COMBUSTION, DRAFTS, TEMPERATURE OF GASES.		
Fuel in pounds:		
Total fired	12,617	12,467
Running fired	11,967	12,300
Fired per hour:		
Total time	3,597	3,967
Running time	4,597	5,436
Rate of combustion per hour:		
Sq. ft. grate area	61.29	72.47
Sq. ft. heating surface	.7799	1.0089
Draft in. of water:		
Smoke box	6.12	7.24
Fire box	2.09	2.19
Temperature of escaping gases:		
Front smoke box	376.1	514.2
Combustion chamber	599.4	.....
Back of baffle plate	.....	527.0
Back of reheater	463.8	.....
Coal by analysis:		
Volatile matter	16.85	17.18
Fired carbon	74.5	77.3
Ash	8.65	5.52
B. T. U.	13,824	14,311
Pounds per hour:		
Coal	4,597	5,436
Per sq. ft. grate area	61.29	72.47
WATER AND STEAM.		
Pounds of water, total:		
Supplied to injector	109,175	98,133
Injector to overflow	725	551
Supplied to boiler	108,540	97,582
Temperature of feed water	68.35	60.3
Pounds of steam per hour, running time:		
Moist steam by boiler	41.134	43,126
Pumps and calorimeter	3,024	2,606
Pop discharge	5,024	1,936
To cylinder	33,085	38,584
Per sq. ft. heating surface	7.0	8.0
Temperature of water leaving reheater.	235.6.	......
PRESSURE, QUALITY, PRESSURE AND TEMPERATURE AT REHEATER.		
Pressure pounds per sq. in.:		
Boiler	191.3	193.2
High Pressure delivery	167.8	165.2
Low pressure delivery	54.9	48.[illegible]
Quality of steam, per cent. moisture:		
High pressure delivery	.943	.83
Low pressure delivery	1.108	2.02
Temperature of Steam:		
Entering reheater	306.94	
Leaving reheater	301.53	
Degree reheat	—5.41	
Pressure steam:		
Entering reheater	59.29	
Leaving reheater	54.9	
EQUIVALENT EVAPORATION.		
Ratio total coal to total water	8.666	7.83
Equivalent evaporation from and at 212 degs. F.:		
Total	130,880	118,276
Per hour:		
Total	49,643	52,270
Per sq. ft. heating surface	8.4211	9.70
Per pound of coal	10.46	9.49
INITIAL PRESSURE FROM INDICATOR CARDS.		
Initial pressure pounds per sq. in.		
High pressure cylinder.		
Right side.		
H. E.	177.5	.....
C. E.	177.9	.....
Left side.		
H. E.	174.4	162.[illegible]
C. E.	176.5	161.[illegible]
Low pressure cylinder.		
Right side.		
H. E.	51.9	45.7
C. E.	49.3	45.5
Left side.		
H. E.	52.9	45.4
C. E.	53.4	45.5
BACK PRESSURE FROM INDICATOR CARDS.		
Back pressure pounds per sq. in.:		
High pressure cylinder.		
Right side.		
H. E.	64.9	
C. E.	63.1	
Left side.		
H. E.	62.9	50.6
C. E.	62.8	50.1
Low pressure cylinder.		
Right side.		
H. E.	10.64	8.7
C. E.	10.06	8.34
Left side.		
H. E.	14.24	9.05
C. E.	13.32	8.88
MEAN EFFECTIVE PRESSURE.		
High pressure cylinder.		
Right side.		
H. E.	84.9	89.5
C. E.	86.1	93.1
Left side.		
H. E.	84.4	95.1
C. E.	87.8	96.0
Low pressure cylinder.		
Right side.		
H. E.	29.1	30.2
C. E.	28.9	30.0
Left side.		
H. E.	28.4	30.2
C. E.	29.2	29.5
INDICATED HORSEPOWER.		
High pressure cylinder.		
Right side.		
H. E.	188.8	215.3
C. E.	189.1	220.3
Left side.		
H. E.	186.5	228.2
C. E.	192.7	226.1
Low pressure cylinder.		
Right side.		
H. E.	161.5	180.9
C. E.	160.3	177.7
Left side.		
H. E.	157.6	180.9
C. E.	161.2	174.9
DISTRIBUTION OF POWER.		
Indicated horsepower.		
Right side.		
High Pressure	377.9	435.6
Low pressure	321.8	358.6
Left side.		
High pressure	379.2	454.3
Low pressure	318.8	355.8
Total.		
Right side	699.7	794.2
Left side	698.0	810.1
All cylinders	1,397.7	1,604.3
Cylinders:		
High pressure	757.1	889.9
Low pressure	640.6	714.4
Ratio of high to low pressure	1.18	1.25
HORSEPOWER—EFFICIENCY.		
Indicated horsepower:		
High pressure cylinders	757.1	889.9
Low pressure cylinders	640.6	714.4
All cylinders	1,397.7	1,604.3
Draw bar pull, lbs.	40,363	46,021
Draw bar h. p.	1.093.7	1,347.0
Boiler h. p.	1,439	1,515
Boiler efficiency	77.1	64.9
HORSEPOWER RELATION.		
Horsepower:		
Indicated:		
Per sq. ft. heating surface	.237	.298
Per sq. ft. grate area	18.6	21.4
Drawbar:		
Per sq. ft. heating surface	.186	.250



HIGH AND LOW SPEED INDICATOR CARDS.

Per sq. ft. grate area	14.6	18.0
Boiler at dome	1,439	1,515
POUNDS OF STEAM THROUGH CYLINDERS PER THOUSAND TON MILES.		
Per thousand ton miles including weights of engine and tender	43.046	44.955
Per thousand ton miles excluding weights of engine and tender	50.802	52.429
Water through cylinders—pounds:		
Per thousand ton miles excluding weight of engine and tender	2,020	1,943
Per thousand ton miles including weight of engine and tender	1,711	1,665
Total	86,890	87,273
B. T. U. through cylinder per thousand ton miles including weights of engine and tender	2,050,900	1,996,331
HORSEPOWER.		
Speed M. P. H	11.06	13.12
Indicated horsepower:		
High pressure cylinders	757.1	889.9
Low pressure cylinders	640.6	714.4
Total I. H. P	1,397.7	1,604.3
Drawbar pull, pounds	40,363	46,021
Drawbar H. P	1,093.7	1,347
Ratio I. H. P. to drawbar H. P	1.28	1.19

The carefulness and accuracy with which the tests were made is well illustrated by the description of the methods used, given below:

COAL MEASUREMENT.

In determining the amount of coal used on this test the coal was sacked, 100 pounds to the sack, and was emptied on the fuel deck to the fireman according to his requirements. An effort was made to have a nice, clean, uniform fire at the beginning of each trip and to burn the fire down approximately to the same condition at the end of each trip. Coal used during delays was accounted for separately.

WATER MEASUREMENTS.

The tank used in connection with this test was carefully calibrated, gauge boards being used at each corner of the tank, and hose was connected both at the front and rear, by having a glass tube in the end of the hose and holding it against the gauge boards, the amount of water at all four corners of the tank could be accurately determined; these determinations were made at the beginning and end of the test, as well as befor and after taking water en route. The initial and final water observations were made with the engine standing on the same track elevation. The water in the boiler was marked on the gauge glass before starting and before the final measurements from the tank were taken at the end of each trip; the boiler was filled to the same point as before. The elevation of the boiler was determined by the use of a level, which determined this feature accurately.

The water losses were taken into consideration, the injector overflow was collected and measured; the steam consumed by the air pumps was indicated by stroke counters connected to both pumps, which gave a basis for calculation; the loss through calorimeters was also noted and necessary corrections made. In accounting for the loss through the pops, the pop casings were drilled and tapped and plugs with a 1/16 in. diameter orifice were screwed in flush with the inside of the casing; these plugs were then connected to a pipe line running back to a condensing coil in the tank. By this scheme a small per cent. of the steam discharged through the pops passed through these orifices and was condensed and collected in a small tank arranged for this purpose. With the engine stationary, and the boiler full of water, engine was fired to keep the pops up until the height of the water in the boiler receded to the bottom of the gauge glass. The injectors were then put on and the boiler filled to the original point. With the use of the calibrated tank, we were then able to determine the amount of water required to fill the boiler which corresponded with the amount discharged through the pops. The ratio of the water discharged through the pop to the water collected from the condenser gave us the desired percentage for determining the pop loss on each trip.

PRESSURE DETERMINATIONS.

All steam pressure determinations were indicated by ordinary steam gauges, which were carefully and repeatedly tested to assure their accuracy; this refers both to the steam pressure gauge on the boiler as well as the steam gauges used in connection with the calorimeters. The atmospheric pressure was determined by use of a marine type barometer which was mounted in the dynamometer car. This instrument was broken on account of running over a derail switch, and only two days' observations were made.

DRAFT DETERMINATIONS.

The draft was shown by open water manometer tubes, one manometer being connected to a line running to the front end; the other was connected to a short pipe which was inserted through the fire door when these readings were taken.

QUALITY OF STEAM.

The quality of steam was determined by using Peabody throttling calorimeters; one of these was attached to the high pressure delivery pipe and the other connected with the steam chest on the low pressure cylinder.

THROTTLE AND REVERSE BAR POSITIONS.

The reverse bar quadrant was stenciled, counting the notches from the center. The throttle opening was determined by taking the dome cap off and marking the valve stem in the cab in increments of 1/16 open. The throttle was accurately adjusted to increments of 1/8 open and the necessary points located on the throttle stem. The position of reverse bar and throttle were registered on the dynamometer chart by operating push buttons in the locomotive cab—one push on the reverse bar button indicating the bar one notch from center: one push on the throttle button indicating the throttle 1/16 open.

THE NICKELIZED CHILLED CAR WHEEL

Nickel and chrome are the most extensively used of all alloys to improve the quality of steel, and a method has now been found to employ them to the same advantage in a chilled wheel mixture. This process, which has been developed by the Nickel-Chrome Chilled Car Wheel Company,* affords one of the greatest improvements that has been made in a chilled car wheel mixture in fifty years, and the results of a recent series of tests made by the Pennsylvania Railroad Company at Altoona, indicate that a very important element of safety has been introduced into railroad practice, with a much increased mileage from the wheel.

The following comparison of a nickelized chilled wheel with a very superior standard wheel, under the M. C. B. drop test, proves that both the elastic limit and the freedom from shrinkage strain were greatly in favor of the former. In this test a 200-pound weight was used, on a 12-foot fall, the requirement being 12 blows.

Nickelized.

305th Blow, small crack developed through core holes
330th, Crack developed
355th, 2nd Crack through tread
359th, Piece broken out of wheel

Standard.

141st Blow, crack through flange across plate
250th, Crack developed
310th, Another crack across tread
319th, Piece broken out of tread

As showing greater resiliency, the nickelized wheel did not begin to crack until the 305th blow, while the standard began to give way at the 141st blow. These wheels were remarkably alike chemically, embodying:

.58 Silicon, in the nickelized.
.60 Silicon, in the standard.

Incidentally the drop test showed also that the nickelized wheel was not on so great a shrinkage strain, it being claimed for the nickel alloy that it has a lower co-efficient of expansion than any other alloy known.

In the service tests which were conducted in connection with the heaviest mountain traffic in the country, one hundred and fifty-six 33-in. nickelized chilled car wheels were put under Berwick 100,000 lb. coal cars. After 12 months, during which one wheel, still running, made 29,966 miles, nine wheels only were withdrawn for defects, showing less than 6 per cent. of the wheels drawn. As the railroads of the country draw on an average 30 per cent. of the car wheels they use every year, only 6 per cent. is a remarkable showing for a first trial, and it may be further enhanced by the fact that no wheel broke in service. Eighty-eight 36-in. nickelized wheels were also tested under locomotive tenders in the same territory, and nine were drawn for "comby from brakes or brake burns," and one for worn tread, with a mileage of 21,260.

The chemical analysis of the wheels that stood the foregoing mechanical and service tests was ideal:

	Sil.	Sul.	Mang.	Phos.	C. C.	Nickel.
Grey Iron	.442	.131	.467	.343	.78	.687
Chill Tread	.441	.110	.483	.342	3.339	.687

In making a nickelized steel car axle, the lowest amount necessary to produce the best results has been fixed at 3½ per cent., or 70 pounds per ton of 2,000 pounds. Owing to the greater amount of combined carbon in a chilled wheel mixture, it is only necessary to use 14 pounds per ton of 2,000 pounds. The present cost of nickel is 38 cents a pound in large quantities. So that $5.32 represents the amount in dollars and cents per ton in a car wheel mixture in the first lot of wheels, but when these are remelted, the new nickel required would only be about $2.25 per ton or seventy-five cents per wheel.

* Frick Bldg., Pittsburgh, Pa.

IN 1905 PLATINUM SOLD AS LOW AS $18.50 PER OUNCE, and even at that figure was not in great demand. To-day it is selling for $43.00 per ounce, a truly astonishing figure, when the price of gold, about $22.00 per ounce, is considered. The great increase in the manufacture of incandescent lamps is the principal cause for the advance in price.

The Street Locomotive Stoker

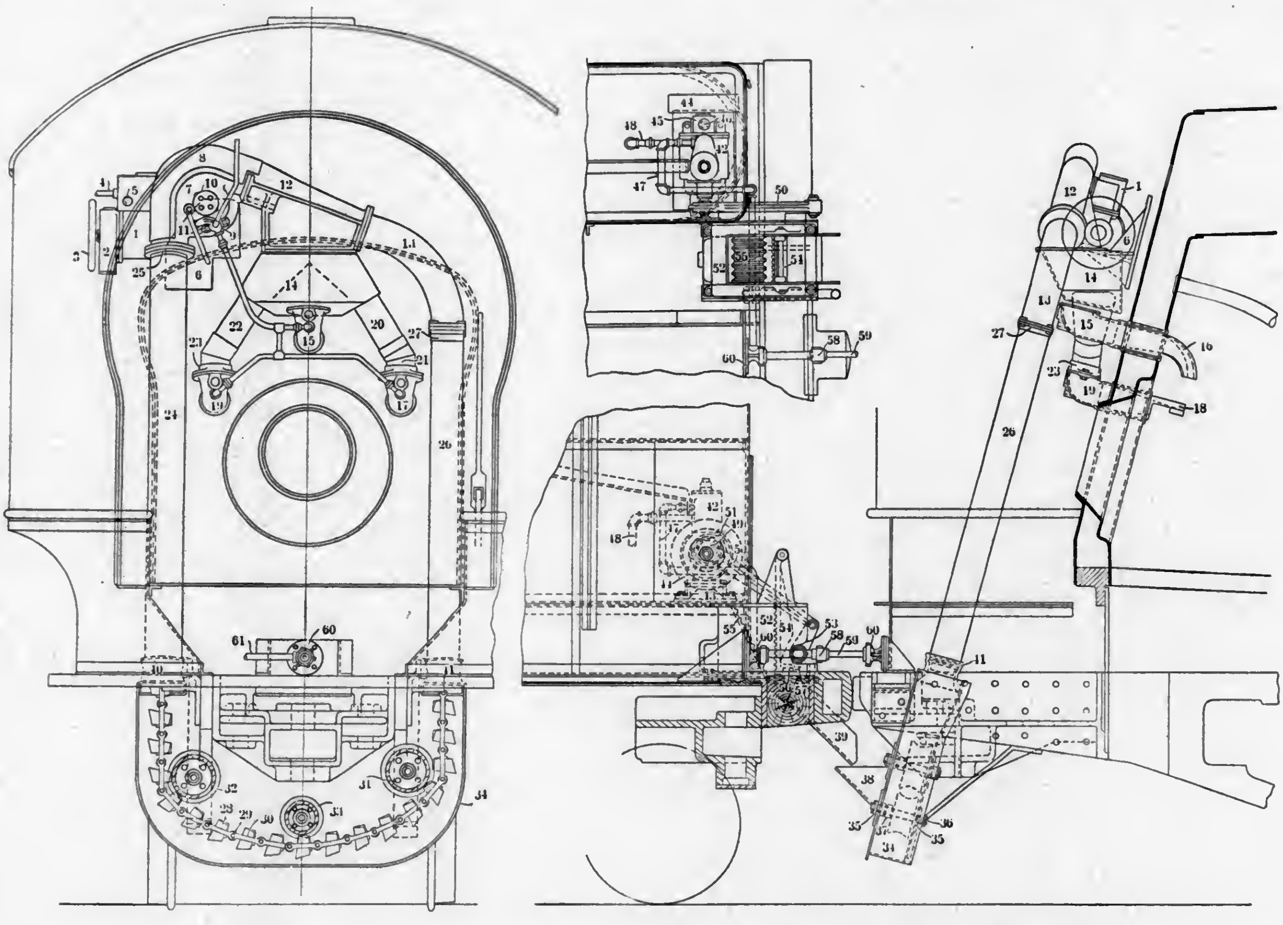
A STOKER FOR LOCOMOTIVES WHICH INCLUDES A CRUSHER, ELEVATOR AND FUEL DISTRIUTING ARRANGEMENT ALL PERMANENTLY ATTACHED TO THE LOCOMOTIVE, WHILE AT THE SAME TIME NOT IN ANY WAY INTERFERING WITH THE USE OF THE FIRE DOOR OR INTERIOR FIREBOX ARRANGEMENT

Guided by the conviction that a locomotive stoker should be part of the locomotive, as distinguished from a portable device, that it should be capable of handling any reasonable amount of fuel of any character with which the engine might be supplied, that it should not in any way interfere with the use of the fire door and that it should carry the minimum possibility of accident and maximum in flexibility of control, Clement F. Street has designed the apparatus shown in the accompanying illustrations, which, during the past two years, has been remarkably successful in operation on both the heaviest type of Mallet freight engines and on high speed freight trains scheduled at passenger train speed.

This stoker has proved itself under these conditions to satisfactorily fulfil all reasonable requirements in connection with handling large quantities of fuel, giving perfect combustion, which means smokeless combustion and in proving its reliability and flexibility while running in pooled service.

The principle on which ths stoker is designed, viz., the steam jet or scatter type, is one which permits the lower grades of fuel to be satisfactorily burned, giving a high combustion efficiency at low fuel cost. It is also one which, because of the constant and steady injection of fuel, maintains a very constant firebox temperature, resulting in a decided decrease in boiler maintenance with its often accompanying engine failures and roundhouse delay.

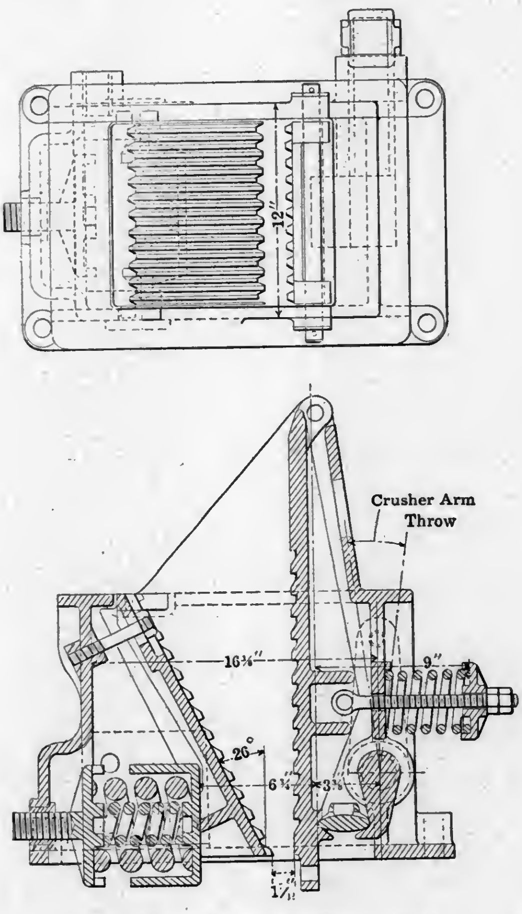
Reference to the illustrations will show that the stoker per-



1. Elevator Engine.
2. Elevator Engine Oil Separator.
3. Elevator Engine Flywheel.
4. Elevator Engine Steam Pipe.
5. Elevator Engine Exhaust Pipe.
6. Elevator Engine Bed Plate.
7. Sprocket Wheel Casing.
8. Sprocket Wheel Casing Cover.
9. Controller.
10. Controller Cam.
11. Controller Lever.
12. Discharge Pipe.
13. Pipe Bend.
14. Distributer Hopper.
15. Center Distributer Elbow.
16. Center Distributer.
17. Right Hand Distributer Elbow.
18. Left Hand Distributer.
19. Left Hand Distributer Elbow.
20. Right Hand Distributer Pipe.
21. Right Hand Distributer Pipe Flange.
22. Left Hand Distributer Pipe.
23. Left Hand Distributer Pipe Flange.
24. 7 in. Elevator Pipe.
25. 7 in. Elevator Pipe Flange.
26. 6 in. Elevator Pipe.
27. 6 in. Elevator Pipe Flange.
28. Elevator Bucket.
29. Elevator Chain.
30. Elevator Chain Link.
31. Lower Hopper Right Hand Sheave.
32. Lower Hopper Left Hand Sheave.
33. Lower Hopper Center Sheave.
34. Lower Hopper.
35. Lower Hopper Sheave Bearing.
36. Lower Hopper Sheave Shaft.
37. Lower Hopper Sheave Collar.
38. Lower Hopper Boot.
39. Coal Chute.
40. 7 in. Bell Mouth.
41. 6 in. Bell Mouth.
42. Crusher Engine.
43. Crusher Engine Bed Plate.
44. Crusher Engine Fly Wheel.
45. Crusher Engine Oil Separator.
46. Crusher Engine Vent.
47. Crusher Engine Steam Pipe.
48. Crusher Engine Exhaust Pipe.
49. Crusher Eccentric.
50. Crusher Eccentric Arm.
51. Crusher Eccentric Arm Cap.
52. Crusher.
53. Crusher Lever.
54. Crusher Swinging Jaw.
55. Crusher Stationary Jaw.
56. Distance Piece.
57. Cam Shaft.
58. Slip Joint Pipe.
59. Slip Joint Pipe.
60. Ball Joint Body.
61. 1 in. Pipe to Crusher Engine.

forms three distinct operations. First, crushing the coal; second, elevating and conveying; third, distributing and injecting. The crushing apparatus is independent and is located on the tender. It consists of a special design swinging jaw crusher with spring release behind the jaws to prevent breakage of its parts. It is operated by a small Westinghouse single acting engine located inside of the end of one of the tank water legs, which is partitioned off for this purpose. The crusher itself is placed on the left-hand side on a level with the floor of the tender, so that the coal is simply shoved into it, the fireman often using his foot for this purpose. It will handle run of mine coal in lumps 8 x 10 in. and crushes it to a size which will pass through a 1½-in. slot. The crusher operates continuously and requres no attention other than an occasional oiling of the engine bearings. Below the crusher there is a sheet iron trough or chute extending downward at an angle of about 45 degs., which discharges the coal into a hopper located on the bottom of the elevator casing underneath the deck. This hopper is wide enough to allow for the changes in position of the engine and tender.

The elevator consists of a double endlesss chain with specially



CRUSHER USED WITH STREET STOKER.

shaped malleable iron bucket having a capacity of about 34.5 cu. in. This chain travels in a casing made of iron piping of suitable size, being guided at the bottom by three adjustable rollers and driven by specially designed steel sprocket wheel located in the upper left-hand corner, the conveyor operating up on the left-hand side and down on the right. It travels at the rate of about 90 ft. per minute. This driving sprocket, completely encased, is driven through a worm gear by a single acting Westinghouse engine secured to the boiler head just behind it in a position where it offers minimum of obstruction. Below the deck plate the elevator with its guiding rolls is enclosed in a sheet iron casing, protecting it from damage.

The crushed fuel is fed to the elevator buckets through the hopper in the casing and is carried up the left-hand side and after passing over the driving sprocket makes a sharp turn downward and passes through a cylindrical screen. The four quarters of this screen are perforated with holes of different diameters. They are ¼ in., 5/16 in., ⅜ in., and ½ in. By rotating this screen so that one or the other of this set of holes are brought beneath the buckets the quantity of coal passing through can be varied. The fine coal passing through this screen drops into the passage leading to the center nozzle. Beyond the screen the buckets pass over a hopper in which there is a deflector plate that can be adjusted so as to turn more or less coal to the right or left. This deflector plate is arranged so that the rolling of the locomotive does not affect its operation.

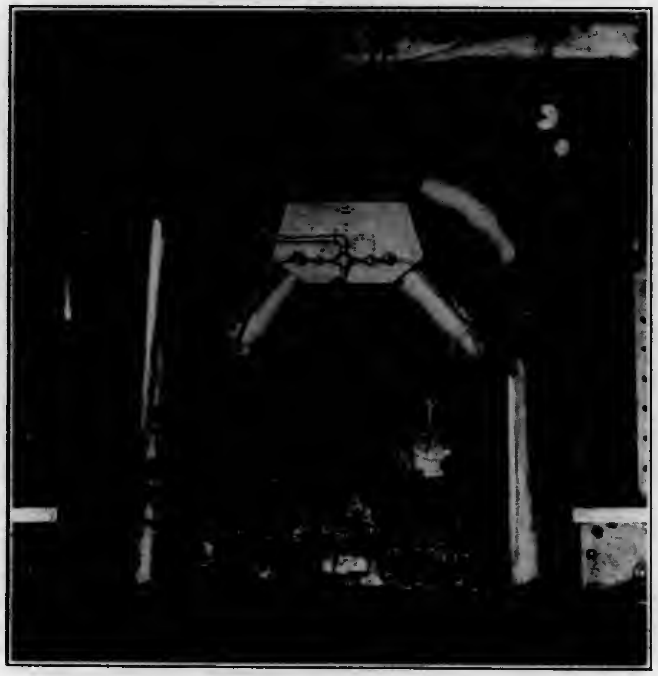
There are three injector nozzles, one being central over the fire door; the other two on the sides lower down. The deflector plate is adjustable and controls the distribution to the outer nozzles and the screen to the center. This scheme makes it possible to easily control the distribution as desired. Reference to the illustrations will show the location of the nozzles and their connection with the elevator system.

Each of the three nozzles are made of cast iron with an elbow outside and pass through large tubes rolled and beaded into the back head of the boiler and firebox sheet. They extend a short distance inside of the firebox and the center one has a downward projection, which directs the fine fuel emerging from it into the back corners and back part of the box, where there is the least tendency to draw it unconsumed into the flues. The side nozzles have an extension which carries a small lip that, while it does not interfere with the coal emerging from the nozzle sufficiently to change its direction, does act as a scattering arrangement and tends to scatter coal over the front end of the box and along the side sheets on either side.

The coal falling down through the distributing system is deposited at the back end of these nozzles just in front of the steam jets, which, acting intermittently, inject it into the firebox. All three steam jets act in unison, being connected to the same steam pipe, which receives its supply direct from the boiler. In this steam line is inserted a spring seated valve, which is secured to the casing enclosing the driving sprocket of the elevating system. The spring of this valve holds it in a closed position and it can only be opened by forcing the projecting stem of the valve inward against the spring. This movement is performed by the latch on the end of the lever centrally hinged, which carries a roller at its upper end. It is provided with a handle on the lower end. The end of the driving sprocket axle extends through the casing and carries a small drum against which the roller on the lever just mentioned has a contact. On the inside of this drum are four cams which can be raised independently and when so raised will come in contact with the roller and put the lever into action, which in turn, if the latch on the lever is in the proper position, will open the spring valve intermittently, allowing a powerful puff of steam to emerge from the nozzles. One or more of these cams are put into operation, depending upon the quantity of fuel that is being handled by the conveyor, which in turn depends upon the amount being put through the crusher. If for any reason it is desired to stop the injection of coal into the firebox while the elevator is still delivering the amount already crushed, the latch on the lever can be dropped down, which closes off the steam supply instantly.

All of this apparatus is rigidly secured to the back head of the boiler and locomotive frames, and while occupying considerable room in the cab it is in such a location as to interfere in no way with the engineer or with the fireman in case it is necessary to hand fire. The fire door opening and connections are entirely unobstructed, permitting the easy inspection of the condition of the fire and the use of a hook if necessary. The apparatus when once started and properly adjusted does not require attention, since the supply of coal being delivered is controlled by the supply put into the crusher.

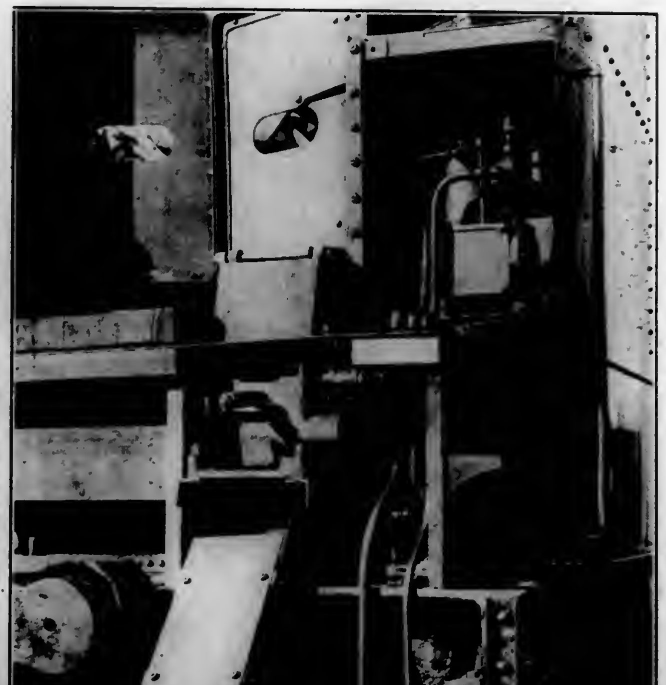
On the L. S. & M. S. Railway there are several large consolidation locomotives running in the regular pool out of Col-



GENERAL VIEW IN CAB OF CONSOLIDATION LOCOMOTIVE EQUIPPED WITH A STREET STOKER.

ARRANGEMENT OF STEAM JET CONTROL OF STREET STOKER.

VIEW SHOWING CASING ENCLOSING ELEVATOR UNDER CAB.



CRUSHER, CRUSHER ENGINE AND CHUTE ON TENDER.

linwood, which are equipped with this stoker, and a recent unheralded visit of a representative of this journal the first locomotive equipped with the stoker that was ordered out was boarded for an inspection trip. This engine was assigned to a fast freight run, was in charge of an engine crew which had had no more service with the stoker engine than other crews of the same pool. The locomotive, a large consolidation, was forced practically to its capacity and the ease with which the

DRIVING SPROCKET AND DETAIL OF ELEVATOR.

steam pressure was maintained without variation was remarkable. In the firebox the fuel bed was level, incandescent and thin, being in practically perfect condition. The box was filled with an incandescent flame to a much greater extent than is obtained under hand firing conditions, showing that a large part of the fine fuel was consumed in suspension. The stack showed only a moderate amount of smoke for short intervals, emitting practically no smoke for most of the time.

This design of stoker was applied and has been operating most successfully for several months on the large Mallet compound locomotive which was illustrated on page 136 of the April, 1910, issue of this journal. It has also been applied to engines of the same type on a number of other roads.

PENNSYLVANIA RAILROAD TO RETAIN JERSEY CITY TERMINAL.—On account of the various rumors that the Pennsylvania Railroad is about to dispose of its Jersey City terminals, Samuel Rea, first vice-president of the company, has stated that there is no foundation in the report. While the road's main passenger station is now in Manhattan, and, with the inauguration of the joint service with the Hudson Company between Park Place, Newark, the Manhattan Transfer and the Hudson Terminal at Church and Cortlandt streets, few passenger trains in addition to express and mail trains will run to Jersey City, the station there is one of the most valuable railroad company terminals on the New York harbor, and its continued use for railroad purposes is assured. The Lehigh Valley uses the terminal for all its passenger service and will continue to do so, as far as anybody is prophesying.

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A NEW STYLE TRUCK-LEVER CONNECTION

There has recently been placed upon the market a truck-lever connection of a design embodying remarkable strength with both simplicity and novelty. In the past various styles of truck-lever connections or bottom rods have been used, made either from wrought, round iron with welded ends, or the jaw material drawn down to round to the required length with one welding in the middle. There is also the malleable iron bar and the combination of malleable jaws and other material.

The new detail here illustrated is made from open-hearth bar steel of ½ in. thickness. In the process of manufacture the bars are cold sheared to correct length, the jaws are re-enforced, material forming part of the pin holes being pushed out to give the added bearing surface for an M. C. B. pin, after which the entire bar is hot-pressed into its inverted U shape and closed at the bottom as shown in the illustration.

When considering the truck-lever connection in its relation to the other details forming the brake rigging, it should be borne in mind that, with the exception of the push rod, this connection is the only member which is subjected to a compression load, and when, in addition to this fact there is a more or less eccentric loading due to offset or even slightly crooked bars, it should be apparent that the material in this new connection is placed far more efficiently for a compression load. A maximum of material in the outer fibers of the bar with a corresponding increase in depth and width of section and a decrease in the weight as compared to the solid round bar, forms an ideal column section to resist compression loading.

Briefly, the principal superior features of this design of truck-lever connection may be thus enumerated:

No welded joints; correct distribution of material for compression load and corresponding greater factor of safety over

NEW TRUCK-LEVER CONNECTION OF INCREASED STRENGTH.

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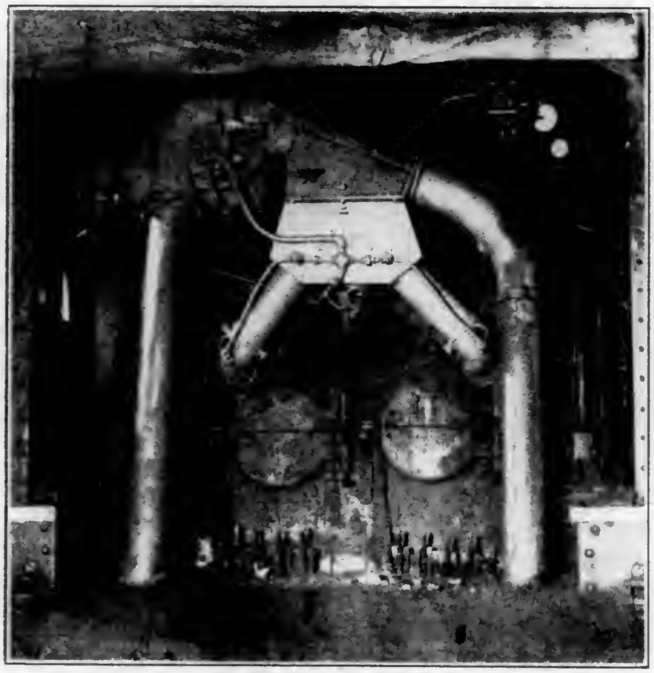
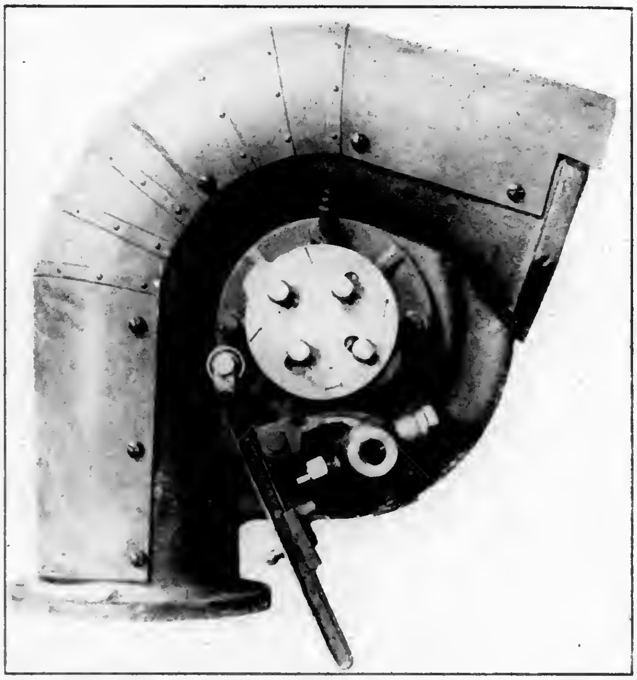
During the development of this detail a series of tests were made first to determine the most efficient sections, and secondly to find the strength of this connection in direct comparison with other round, welded bars. The Pittsburgh Testing Laboratory performed all these tests on an Olsen testing machine of 200,000 pound capacity. The bars were supported in a manner imitating service conditions, and, without going into the detail of these numerous test results, it is of interest here to note that in comparison with the welded type of bar, all salient dimensions being the same for the two bars, the solid forged connection developed from 60 to 440 per cent. greater compressive strength than the welded connection.

Copies of test matter and other information may be had from the Union Equipment Company, 2312 Oliver Building, Pittsburgh, Pa.

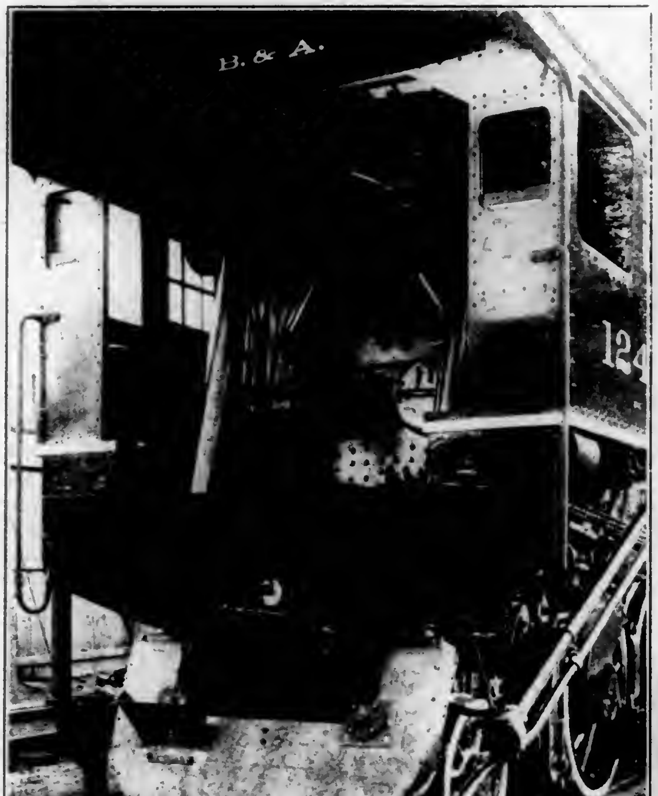
THREE YEARS TO COMPLETE GRAND TRUNK PACIFIC EXTENSION.—According to a railroad official who is in close touch with the construction activities of the Grand Trunk Railway on its Rocky Mountain section and the extension line to Prince Rupert, the western terminus of the road, it will be quite three years before the line is completed to the coast. Unusual engineering difficulties in the mountain section, and the present scarcity of labor, for which there is no relief in prospect, combine to delay completion.



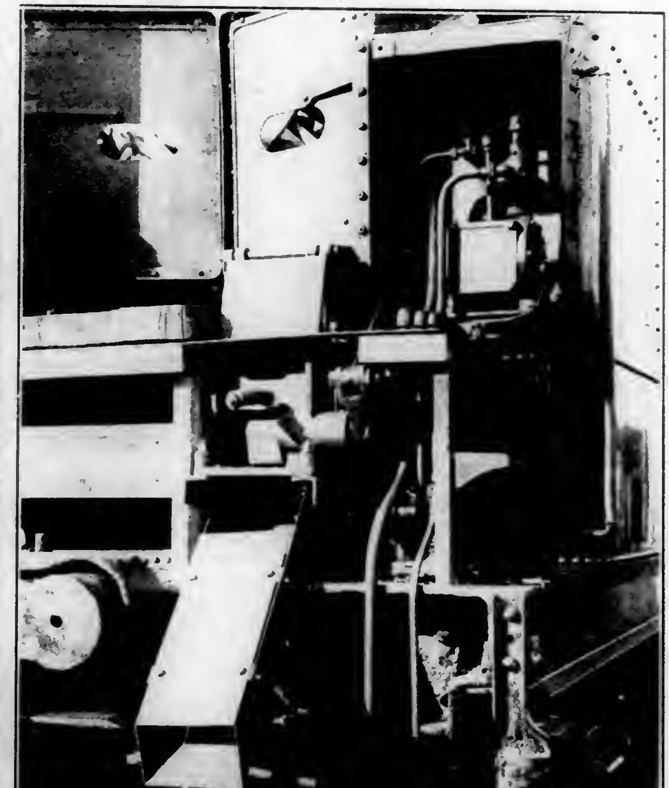
CLOSE VIEW IN CAB OF CONSOLIDATION LOCOMOTIVE EQUIPPED WITH A STREET STOKER.



ARRANGEMENT OF STEAM JET CONTROL OF STREET STOKER.



B. & A. SHOWING CASING ENCLOSING ELEVATOR UNDER CAB.



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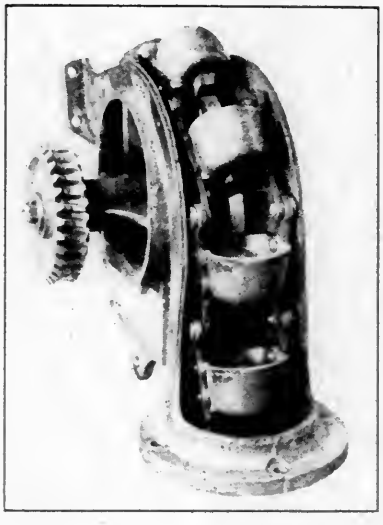

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Copies of test matter and other information may be had from the Union Equipment Company, 2312 Oliver Building, Pittsburgh, Pa.

THREE YEARS TO COMPLETE GRAND TRUNK PACIFIC EXTENSION.—According to a railroad official who is in close touch with the construction activities of the Grand Trunk Railway on its Rocky Mountain section and the extension line to Prince Rupert, the western terminus of the road, it will be quite three years before the line is completed to the coast. Unusual engineering difficulties in the mountain section, and the present scarcity of labor, for which there is no relief in prospect, combine to delay completion.

Highly Developed Vertical Turret Lathe

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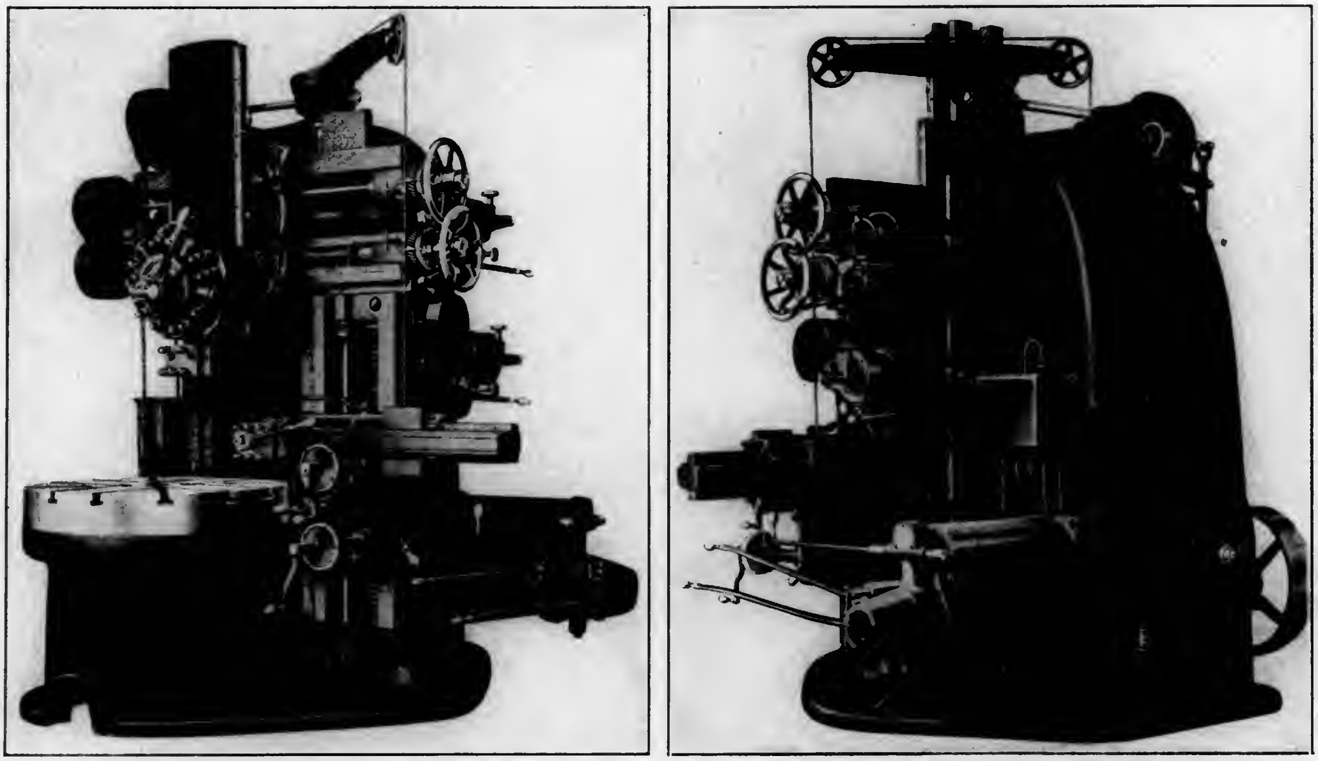
The great range of work that can be performed on the vertical turret lathe is probably not fully appreciated by those who are not sufficiently familiar with its uses. Almost anything that an ordinary lathe can do, and much it cannot perform, is handled on this class of machine; usually in a much shorter time, and in a more satisfactory manner. The 42-inch vertical turret lathe herein illustrated is the latest product in this line of the Bullard Machine Tool Co., of Bridgeport, Conn., who for several years have been developing and perfecting the type. In its present form it may be safely said to meet more nearly than any other machine tool the exacting requirements of extreme power, continued accuracy, absolute safety of operator, great rigidity, convenience of operation, freedom from breakage, and minimum cost of maintenance, which are the demands of to-day and of the future.



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The basic strength of the machine, which is so distinctive a characteristic of the Bullard output, is primarily in evidence. The base and column are cast as a unit; of box construction; internally braced, providing an exceptionally rigid member. It will be noted that the cross rail is of unusual dimensions, and that its bearing on the face of the column is the latter's full width. It is secured to the column by four binding bolts at the extreme points of the bearing. The side rail has the form of an inverted letter "L," being securely fastened to the column and bed by five binding bolts, so located as to give maximum rigidity. The cross and side rails together form a unit having vertical adjustment by power of 14 inches. The maximum efficiency of the vertical slide is thus made available on work of various lengths.

The guide bearing for the rails on the column and bed has great length in proportion to its width, assuring permanency of alignment in the vertical movement of these parts. The same type of guide bearing is provided on the cross rail and side rail for the saddles. The tilting and binding of heads on the rail, due to cutting strain, is thereby prevented; the efficiency of the feed works largely increased, and accuracy fully maintained. The rail and saddle, saddle and slide are solid square locked throughout, no bolted on gibs of inherent weakness being used, and all adjustments for wear are made by taper gibs. The entire general arrangement is representative of rigidity to an unusual degree, although in a casual examination this is somewhat obscured by the extremely graceful contour of the machine as a whole.

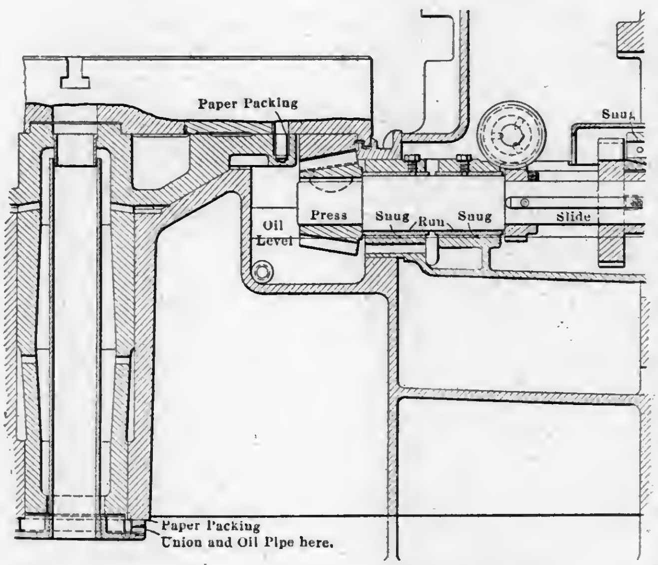
There is one vertical head, which will face 44 inches, with a vertical movement of 27 inches, and one side head, each head being independent in its action, both as to direction and amount of feed. The two heads can be operated jointly on work of small diameter without interference. An absolutely accurate center stop is provided for the main head, which is so designed as to permit the head to be carried beyond the center 3 inches. This stop mechanism is unique in design and does not present the inherent weakness and consequent inaccuracy of the ordinary center stop. The swivel base of the main head has a diameter equal to the full width of the saddle, being secured

thereto by numerous binding bolts, thus adding an element of unusual strength to these parts. Angular adjustment up to 45 degrees on either side of the vertical center is obtained by a system of gearing.

The turret is 16 in. diameter, with five faces, the steel bushed holes therein being 2¾ in. diameter. Being set at an angle the turret will swing large tools clear of the slide. It is revolved by the lever plainly shown in one of the illustrations, one turn being equal to each face of the turret. The turret slide has an exceptionally broad bearing on the swivel base, and is also provided with the type of guide bearing previously referred to. Special provision is made for maintaining alignment with the center of the table. Half-boxes, secured to the turret by two binder bolts, bear on the split steel bushings in the turret holes, securely holding the shanks of tool holders, boring bars, etc. As no frictional binder is sufficient, however, to resist the twisting strain set up by a heavy cut, a pin of large diameter, located at the inner end of the turret holes, enters a slot in the end of the bar or tool holder and acts as a driver. The tool holder may be partially withdrawn and disengaged from the driving pin to properly set a tool for cutting at or near the center, which is not possible with a key or key way.

The side head, which does not swivel, has a vertical movement of 28 in. and a horizontal movement of 21 in. The maximum distance from the table to the underside of the cross slide is 25 in. Quick hand movement in all directions is provided, also means for making fire adjustment, independent of the feed works. A four-faced turret holder on the side head obviates the necessity of a constant change of tools, and 1½ in. by 1¼ in. tool steel may be used.

The table is driven through accurately planed bevel gearing, having a special tooth form, which has a rotative effect only. Experiments extending over a period of many years have proved the bevel drive to be superior to the spur drive—notably in the smoothness of the cut and the absence of chatter and tool marks. The table spindle is of the standard Bullard type, as shown in the sectional drawing, having an angular thrust bearing of large diameter, the side strains being absorbed by vertical cylindrical bearings of exceptionally ample proportions. All bearings are accurately and concentrically ground on a special machine, designed and built for this specific purpose.



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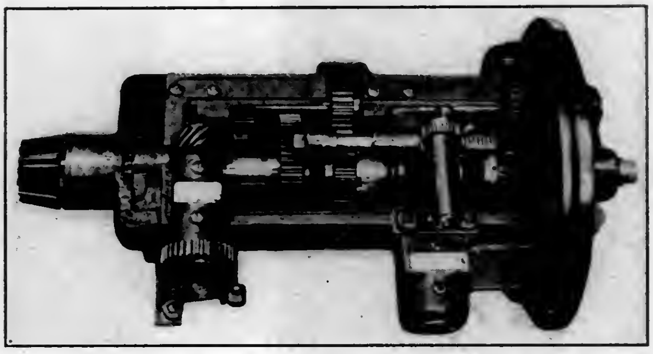
With the main driving pulley running 360 r. p. m., the following 12 speeds are mechanically obtained: 3.1, 4, 5.5, 7.1, 9, 11, 16, 20, 27, 34, 46 and 60 r. p. m. The speed changes are effected through two systems of selective sliding gears, one of which is illustrated, and positive clutches. Only gears transmitting power are in mesh—no power being consumed by idle running gears. It may be of interest in this connection to mention that alloy steel gears, specially heat treated, are used throughout the entire driving and feed train of this machine, with the single exception of the table gear, which is of such proportions that it cannot be successfully heat treated. A special alloy, however, having exceptional wearing qualities in an unhardened state, is used in this gear.

A multiple speed clutch disc, readily adjustable, is interposed between the main driving shaft and the primary speed change device, and the members running at constant speed its efficiency



SELECTIVE SLIDING SPEED GEARS.

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The controlling levers are positively interlocking. The clutch must be released and the brake engaged before a speed change can be made. A complete engagement of gears for any speed is necessary before the brake can be released and the clutch re-engaged. This system of interlocking does not in any way interfere with rapid manipulation, and it serves as an absolute safeguard against breakage due to careless handling. The location of all operating levers and handles in a position convenient to the operator, as is clearly shown in the illustrations, affords an important factor conductive to greater output. Centralized control permits the operator to concentrate on productive effort, which is not interfered with by unnecessary steps from one part of the machine to another. The number of table revolutions per minute may be instantly ascertained from a direct reading indicator incorporated in the interlocking device.

Among the many meritorious features of improvement which may be found in this machine, the refinement to which the feed works and details have been brought is worthy of special consideration. The feed works for each head are entirely independent, and so located as to be conveniently operated. Feeds for both heads are positive and independent, and have 8 changes, ranging from 1/96 in. to ½ in. in all directions. The feed changes are instantly obtained by turning a knurled wheel, and the amount of feed per revolution is indicated on a direct reading index plate on each feed box. The feed is engaged or disengaged, or change made from vertical to cross feed, or vice versa, by engaging the centrally located drop worm gears on the end of feed rod and feed screw. Safety devices which are incorporated in each feed works insure against breakage of gears or mechanism by careless handling of the heads.

The machine is most thoroughly provided with information readings for the operator. An accurately graduated scale is attached to the main turret slide, and a similar scale is made part of the cross rail face. A scale is also attached to the tool slide of the side head; these scales proving of material assistance in the setting of tools. Index dials accurately gradu-

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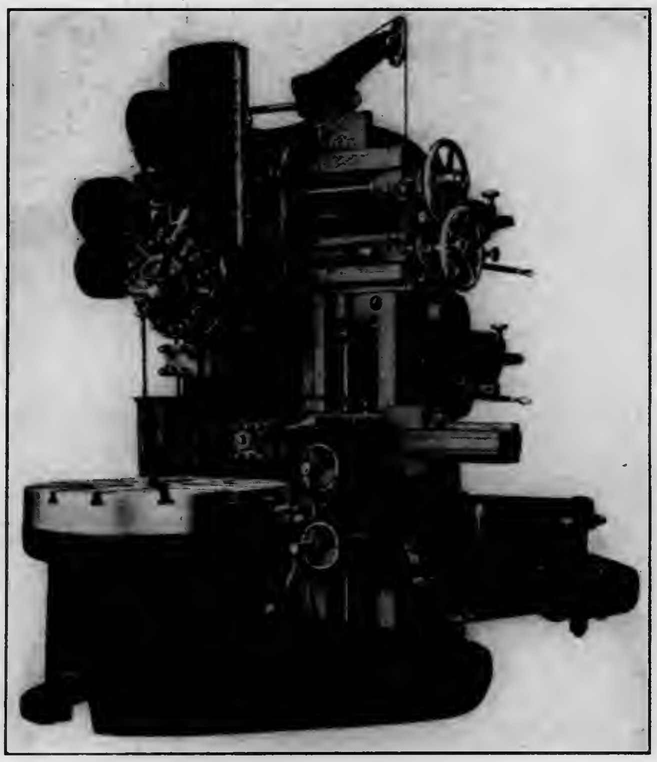
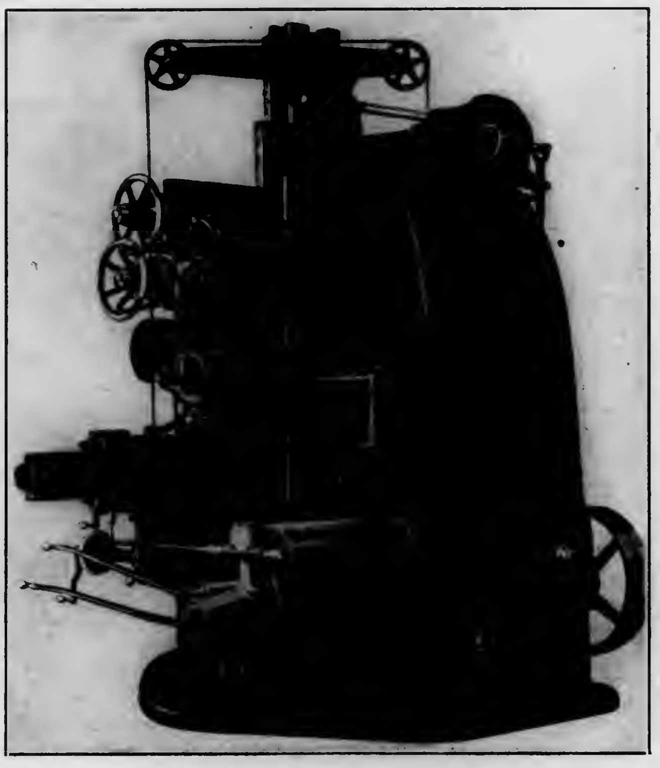

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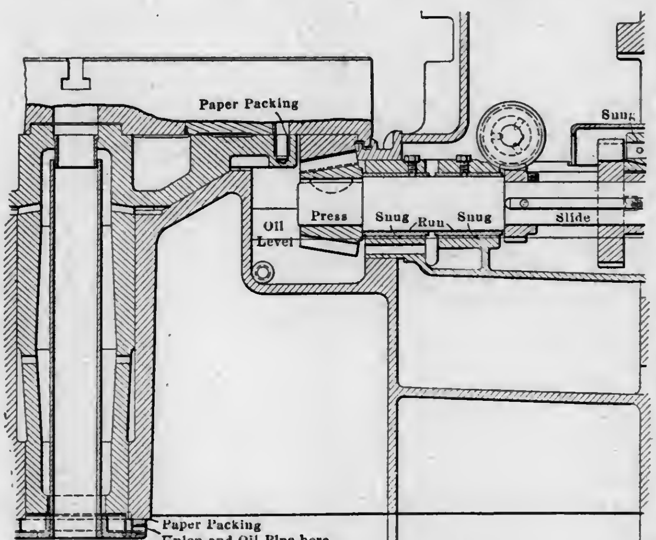

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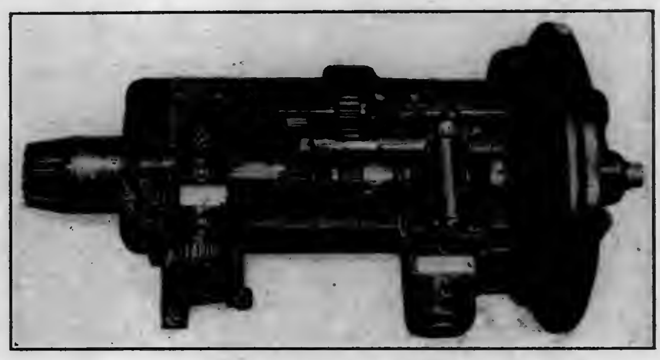

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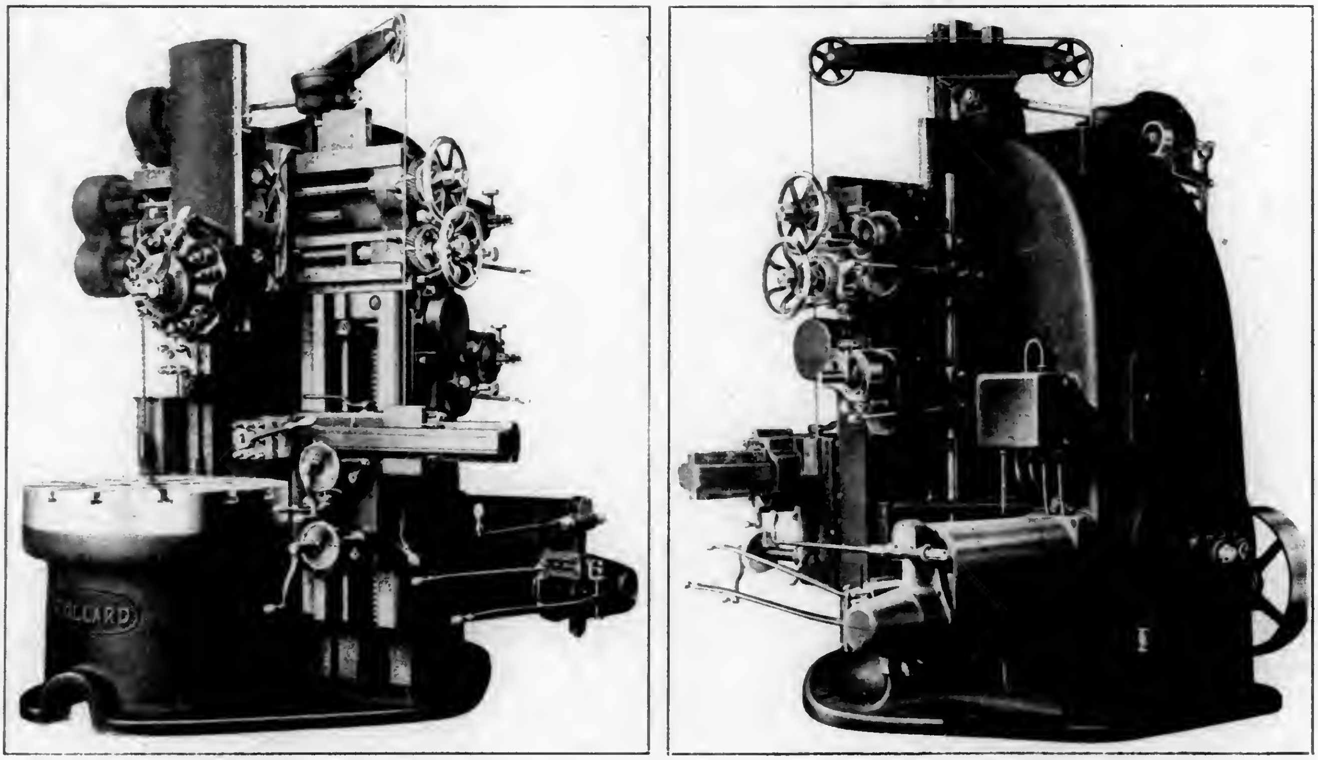

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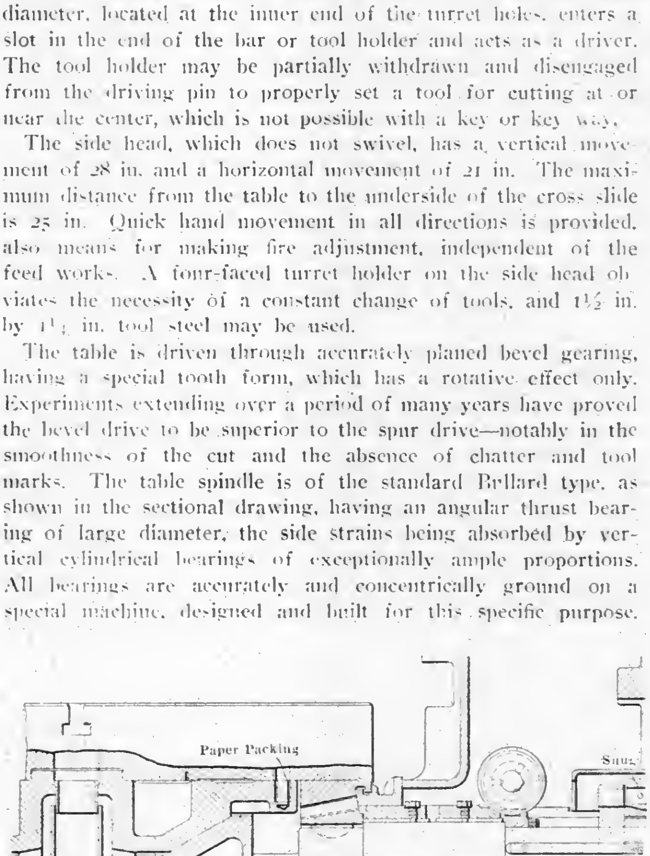

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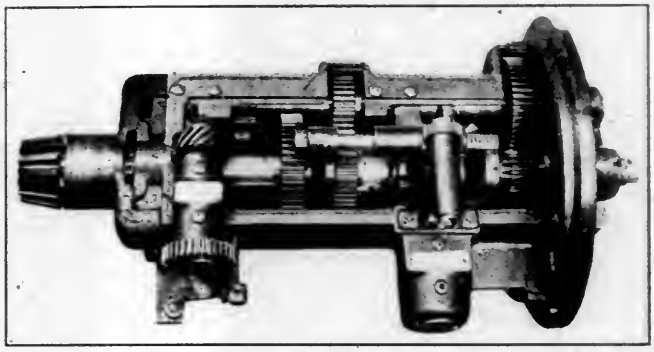

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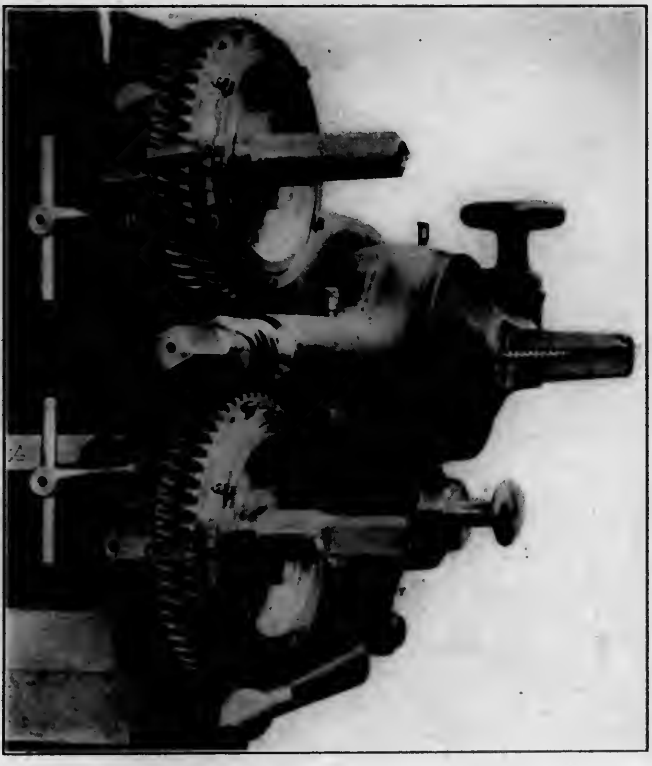
Observation stops, bearing numbers to correspond with those on the faces of the turrets, are adjustably mounted on graduated scales and micrometer dials, and are invaluable in the duplication of various sizes. They do not present the limitations and objectionable features, mechanical and otherwise, of the



MICROMETER DIALS AND OBSERVATION STOPS.

automatic feed trip, which can be set for one dimension only, and is undependable for accurate reproduction.

An original conception which has been worked out in a thoroughly practical manner may be found in the substitution of hand wheels for crank handles on the rod and screw of the main head. These parts, of course, revolve rapidly when power traverse mechanism is engaged, and crank handles would be dangerous. The hand wheels which are mounted on sleeves secured to the rod and screw are free to make a partial revolution on the sleeves before becoming engaged therewith, the engagement imparting a hammer action similar to a hand tap on the end of a crank handle. The arrangement of this part permits of the very finest tool adjustment.

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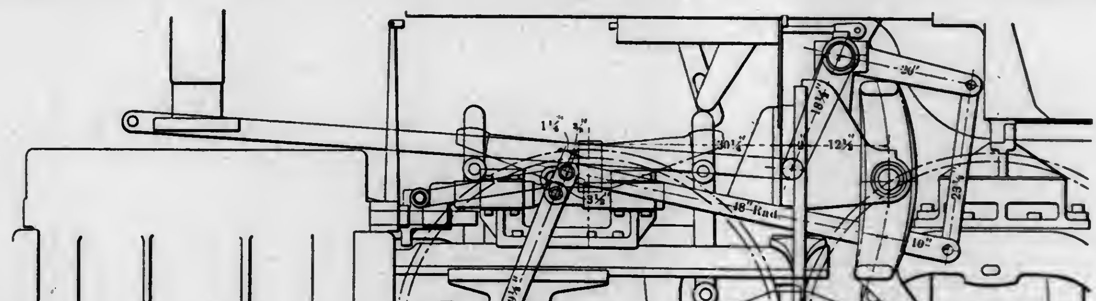
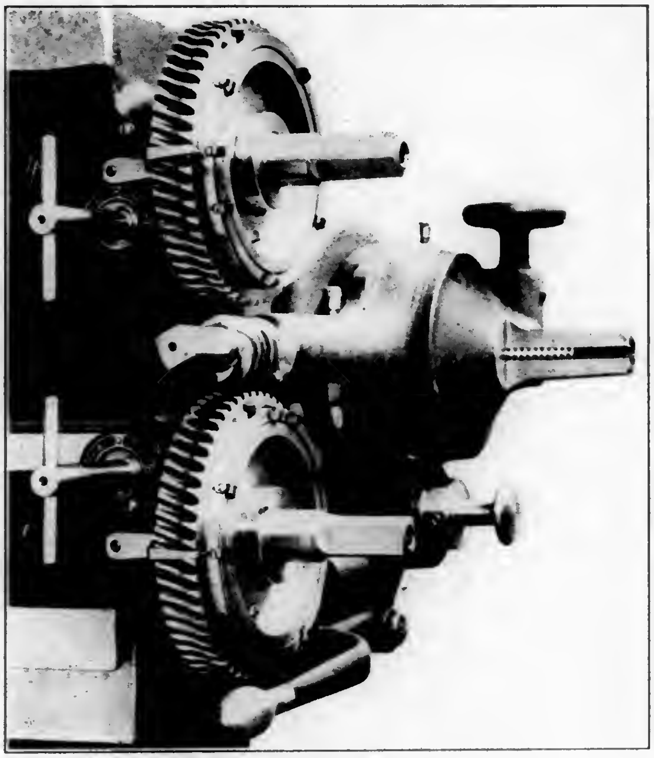


ARRANGEMENT OF VALVE GEAR ON MEXICAN INTERNATIONAL RAILWAY 2-6-6-2 TYPE LOCOMOTIVE.

ated in thousandths of an inch are mounted on the feed rods of both main and side heads. These dials, being of large diameter, have the graduations widely spaced and hence are exceptionally distinct and readable.

Observation stops, bearing numbers to correspond with those on the faces of the turrets, are adjustably mounted on graduated scales and micrometer dials, and are invaluable in the duplication of various sizes. They do not present the limitations and objectionable features, mechanical and otherwise, of the



MICROMETER DIALS AND OBSERVATION STOPS.

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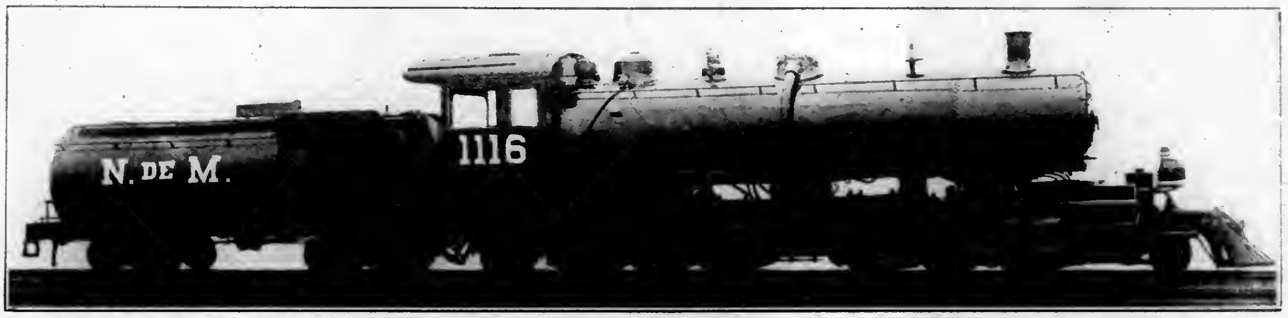

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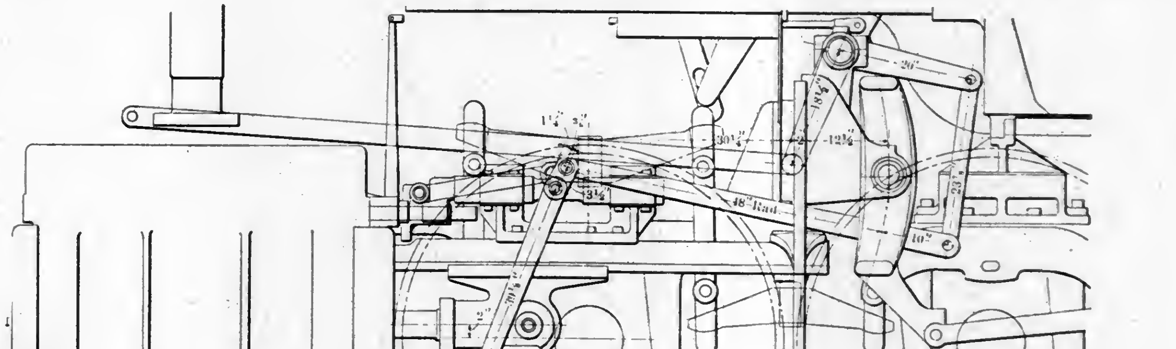

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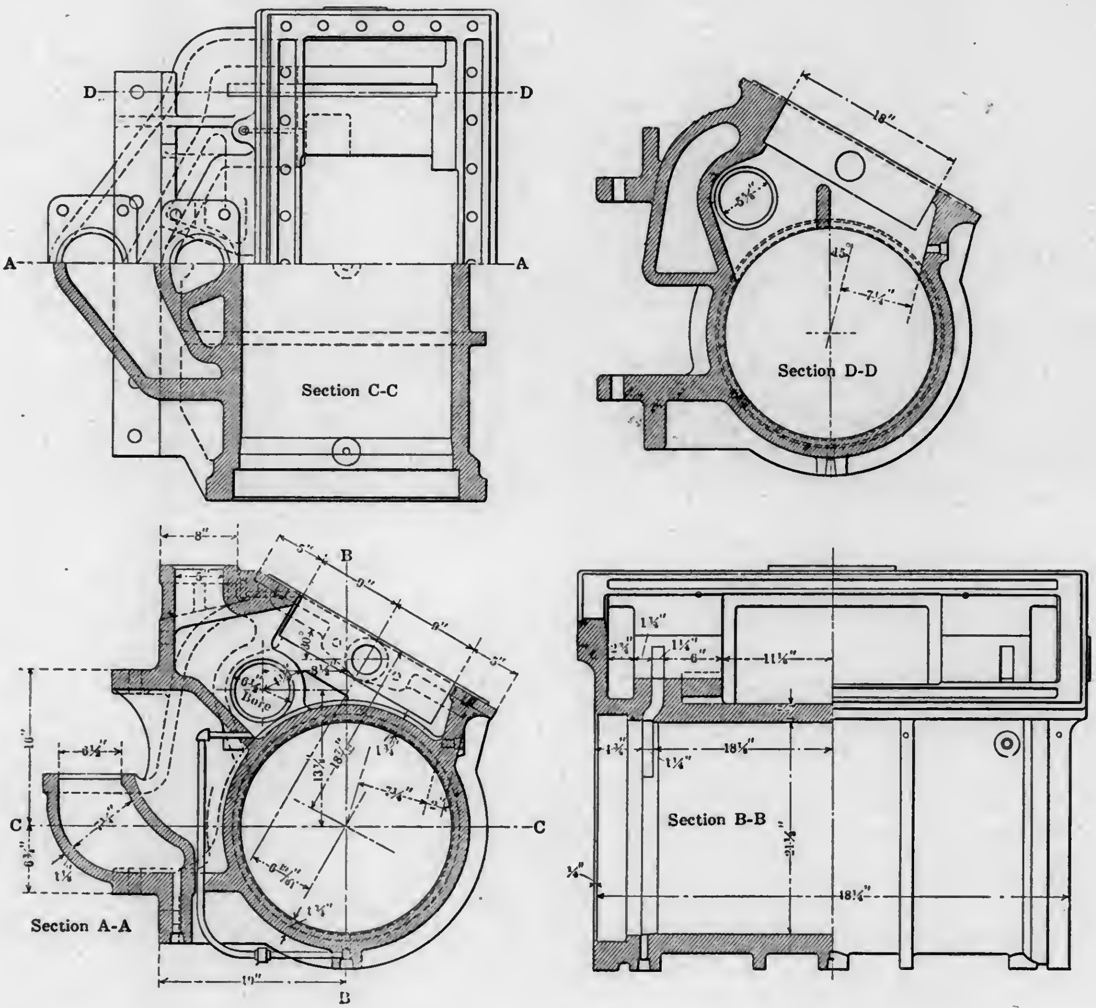
VALVES.

Kind	Hobart-Alfree
Greatest travel	6 in.
Outside lap	1⅛ in.
Inside clearance, H. P.	7/16 in.
Inside clearance, L. P.	⅜ in.
Exhaust clearance, compression valve	⅛ in.
Lead	3/16 in.



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The general dimensions, valve setting, etc., of these locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Oil
Tractive effort	69,500 lbs.
Weight in working order	338,500 lbs.
Weight on drivers	298,200 lbs.
Weight on leading truck	20,000 lbs.
Weight on trailing truck	20,300 lbs.
Weight of engine and tender in working order	510,000 lbs.
Wheel base, rigid	10 ft.
Wheel base, driving	30 ft. 1 in.
Wheel base, total	46 ft.
Wheel base, engine and tender	79 ft. 2½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	4.86
Tractive effort × diam. drivers ÷ heating surface	827.09
Total heating surface ÷ grate area	70.20
Firebox heating surface ÷ total heating surface per cent	4.40
Weight on drivers ÷ total heating surface	63.70
Total weight ÷ total heating surface	71.80
Volume equivalent simple cylinders, cu. ft	20.75
Total heating surface ÷ vol. equiv. cylinders	227.00
Grate area ÷ vol. equiv. cylinders	3.23

CYLINDERS.

Kind	Compound
Diameter	21½ & 33 in.
Stroke	32 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	4 in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	28½ in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	28½ in.
Trailing truck, journals	6 x 12 in

BOILER.

Style	Straight
Working pressure	220 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	124 1/16 x 78 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	6 in.
Tubes, material and thickness	Steel, No. 12 B. W. G.
Tubes, number and outside diameter	365-2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4494 sq. ft.
Heating surface, firebox	207 sq. ft.
Heating surface, total	4701 sq. ft.
Grate area	67 sq. ft.

TENDER.

Tank	Vanderbilt
Frame	6 x 4 in. angles
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Fuel capacity	4,000 gals.

THE McCLELLON LOCOMOTIVE BOILER

There are three features which take precedent in connection with an ideal boiler for locomotives, viz., the greatest evaporation per square foot of heating surface; highest degree of safety and lowest cost of maintenance. In importance these take about the order named.

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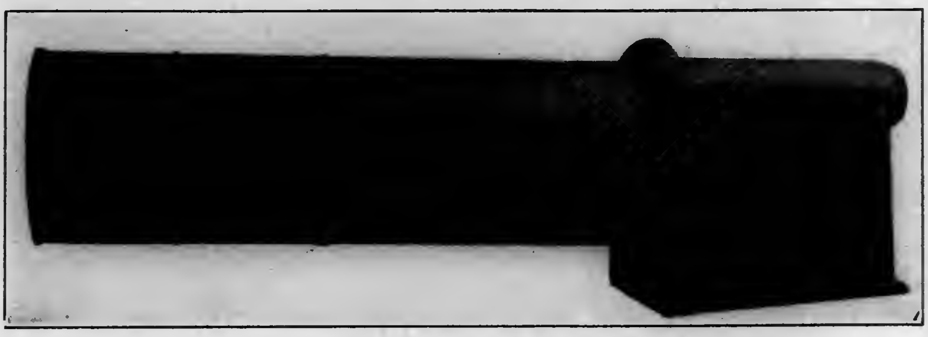

GENERAL VIEW OF THE MCCLELLON BOILER.

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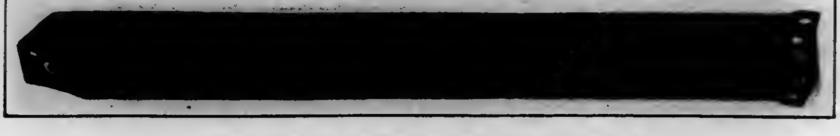
It is with this understanding that James M. McClellon, of Boston, has designed the boiler shown in the accompanying illustrations, which, while it incorporates many of the principles and advantages of the water tube type, differs decidedly from previous designs along those lines and can hardly be classed as a water tube boiler. This design has not been discovered by Mr. McClellon, but is the result of many years' experiment and investigation.

In general, this fire box consists of a series of large tubes flattened on two sides and curved to different radii on the other sides, which are placed adjoining each other with the flat sides in contact for the length of the side wall of the fire box. The back head is made up of similar tubes shaped to take care



TUBE USED TO MAKE UP THE SIDE WATER LEG.

of the difference in width at the top and bottom and arranged to leave an opening for the fire door. At the bottom there is a large ferrule expanded into openings through two adjacent tubes, giving access for the supply of water. The two adjacent tubes are riveted together by four rivets at the point where the ferrule is inserted. At the tops, the ends of the tubes are formed to fit the side of the drums shown in the illustration, and here again a ferrule is expanded in an opening in the tube and drum and four more rivets are used to secure the construction. The top of the tube is closed by a flanged section or head, with the flanges extending upward, the rivets being on the outside, while the bottom is also provided with a similar head. The form of construction at the bottom consists of extending the sides of the tubes down and bolting them to the regular mud ring, this joint not being steam tight, as the flanged heads riveted in the end of the tube hold the pressure.

The upper section of the fire box consists of three large drums, the center one being egg-shaped and the outer two being flattened to form a connection with the center, which are riveted to openings flanged in the back flue sheet and are closed with bumped heads with or without manhole openings at the rear. These three drums, which are large enough to permit a man to work inside, have interconnecting openings fitted with expanded ferrules at frequent intervals. A row of stay rods is inserted across the center drum and adjacent drums are riveted together at the ferrules.

The back flue sheet and the throat sheet take the form of the Bellpaire boiler and are secured together, giving a wide water leg in the manner clearly shown in the illustration. Staybolts, of course, are required for these flat sheets, but at no other point in the boiler are staybolts used.

The opening for the fire door in the back head is arranged

VIEW SHOWING TOP DRUMS OF MCCLEELON BOILER.

by simply cutting away four of the tubes to give the proper space and closing the ends up with flanged heads, the same as are used at the top of the side elements. The bottom sections are provided with extra circulating openings and similar openings are arranged above the fire door. In the case of the back head the elements adjoin the upper drums at the bottom of the shell and are simply shaped for the proper fit and flanged cups or heads inserted and expanded ferrules used the same as on the side elements. Washout plugs, not shown in the illustration, are provided near the top of each element and over the fire doors, or other places wherever necessary.

The shape of the tubes making up the side wall is interesting, the curves on the outer and inner faces have been carefully designed to suit the different conditions of temperature, the inner ones being subject to a greater expansion are curved at a shorter radius and are so arranged as to give a flexibility within themselves, which s capable of taking up all local expansion and not setting up any strains in the connections or having any effect upon the

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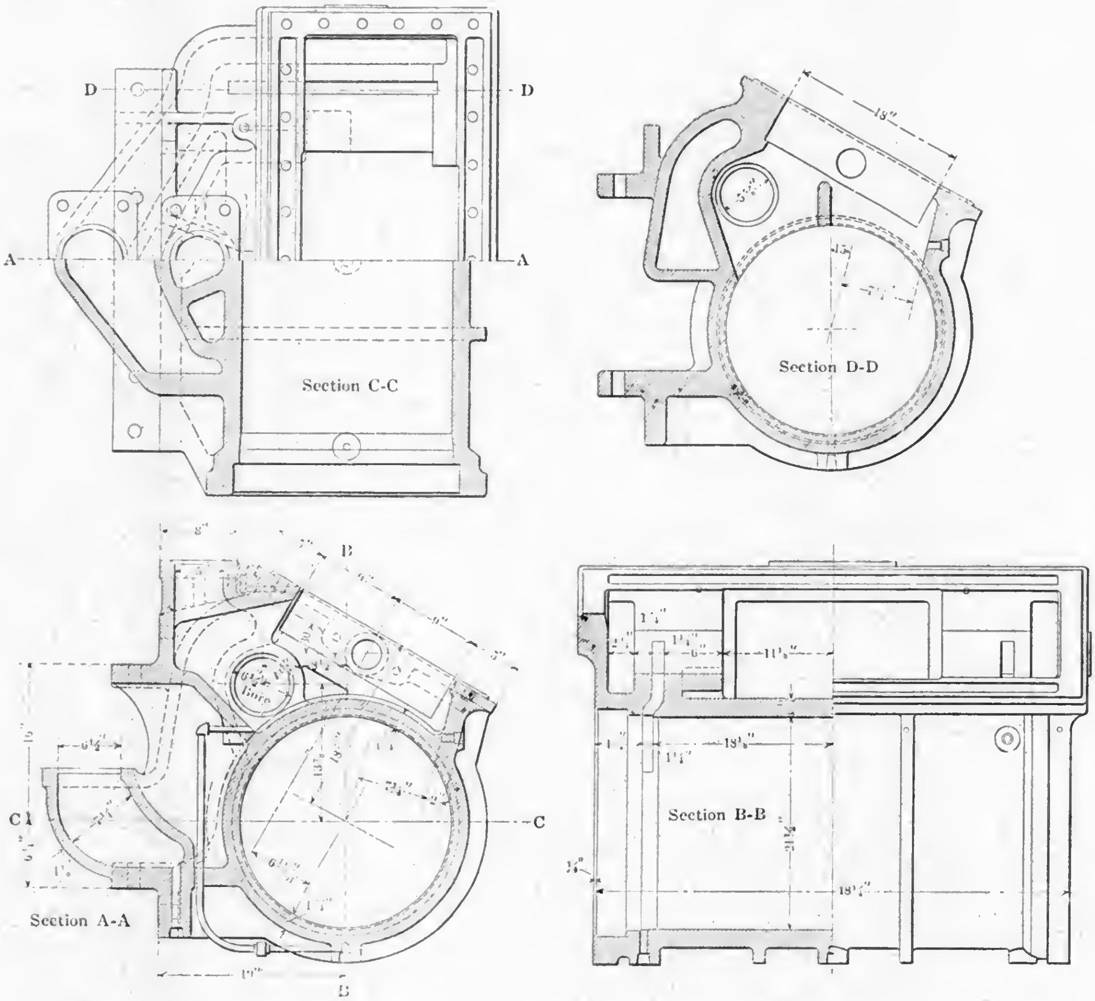

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Wheel base, rigid	10 ft.
Wheel base, driving	30 ft. 1 in.
Wheel base, total	46 ft.
Wheel base, engine and tender	79 ft. 2½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	4.86
Tractive effort × diam. drivers ÷ heating surface	827.09
Total heating surface ÷ grate area	70.20
Firebox heating surface ÷ total heating surface per cent	4.10
Weight on drivers ÷ total heating surface	63.70
Total weight ÷ total heating surface	71.80
Volume equivalent simple cylinders, cu. ft.	20.75
Total heating surface ÷ vol. equiv. cylinders	227.00
Grate area ÷ vol. equiv cylinders	3.23

CYLINDERS.

Kind	Compound
Diameter	21½ & 33 in.
Stroke	32 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	4 in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
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Style	Straight
Working pressure	220 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	124 1/16 x 78 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	6 in.
Tubes, material and thickness	Steel, No. 12 B. W. G.
Tubes, number and outside diameter	365-2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4491 sq. ft.
Heating surface, firebox	207 sq. ft.
Heating surface, total	4701 sq. ft.
Grate area	67 sq. ft.

TENDER.

Tank	Vanderbilt
Frame	6 x 4 in. angles
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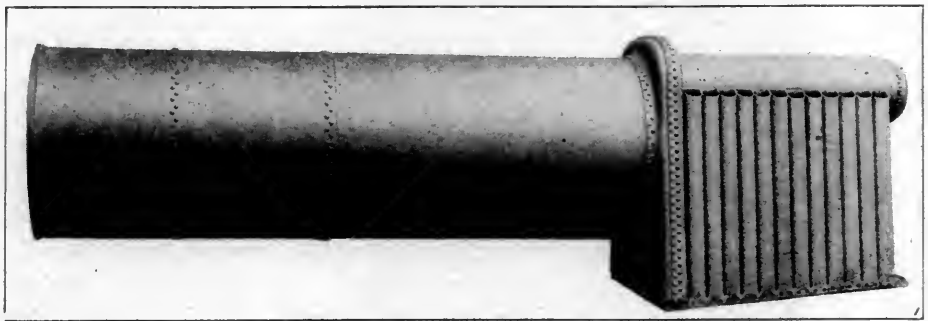


GENERAL VIEW OF THE MCCLELLON BOILER.

It is with this understanding that James M. McClellon, of Boston, has designed the boiler shown in the accompanying illustrations, which, while it incorporates many of the principles and advantages of the water tube type, differs decidedly from previous designs along those lines and can hardly be classed as a water tube boiler. This design has not been discovered by Mr. McClellon, but is the result of many years' experiment and investigation.

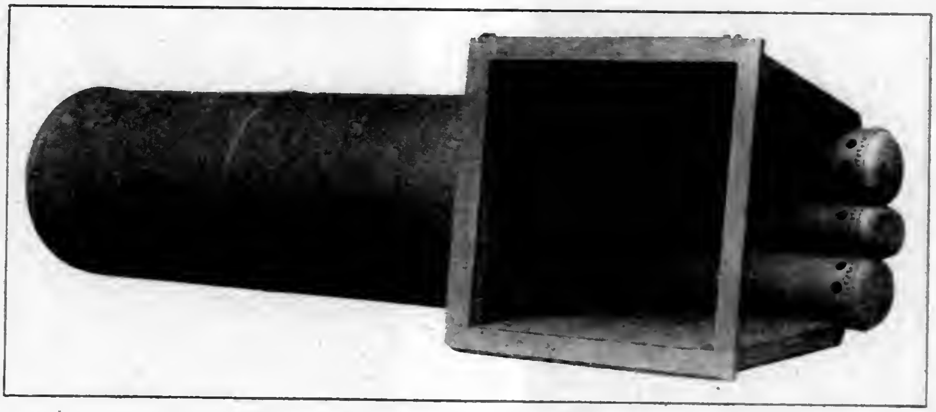
In general, this fire box consists of a series of large tubes flattened on two sides and curved to different radii on the other sides, which are placed adjoining each other with the flat sides in contact for the length of the side wall of the fire box. The back head is made up of similar tubes shaped to take care of the difference in width at the top and bottom and arranged to leave an opening for the fire door. At the bottom there is a large ferrule expanded into openings through two adjacent tubes, giving access for the supply of water. The two adjacent tubes are riveted together by four rivets at the point where the ferrule is inserted. At the tops, the ends of the tubes are formed to fit the side of the drums shown in the illustration, and here again a ferrule is expanded in an opening in the tube and drum and four more rivets are used to secure the construction. The top of the tube is closed by a flanged section or head, with the flanges extending upward, the rivets being on the outside, while the bottom is also provided with a similar head. The form of construction at the bottom consists of extending the sides of the tubes down and bolting them to the regular mud ring, this joint not being steam tight, as the flanged heads riveted in the end of the tube hold the pressure.

TUBE USED TO MAKE UP THE SIDE WATER LEG.

The upper section of the fire box consists of three large drums, the center one being egg-shaped and the outer two being flattened to form a connection with the center, which are riveted to openings flanged in the back flue sheet and are closed with bumped heads with or without manhole openings at the rear. These three drums, which are large enough to permit a man to work inside, have interconnecting openings fitted with expanded ferrules at frequent intervals. A row of stay rods is inserted across the center drum and adjacent drums are riveted together at the ferrules.

The back flue sheet and the throat sheet take the form of the Belpaire boiler and are secured together, giving a wide water leg in the manner clearly shown in the illustration. Staybolts, of course, are required for these flat sheets, but at no other point in the boiler are staybolts used.

The opening for the fire door in the back head is arranged by simply cutting away four of the tubes to give the proper space and closing the ends up with flanged heads, the same as are used at the top of the side elements. The bottom sections are provided with extra circulating openings and similar openings are arranged above the fire door. In the case of the back head the elements adjoin the upper drums at the bottom of the shell and are simply shaped for the proper fit and flanged cups or heads inserted and expanded ferrules used the same as on the side elements. Washout plugs, not shown in the illustration, are provided near the top of each element and over the fire doors, or other places wherever necessary.



VIEW SHOWING TOP DRUMS OF MCCLELLON BOILER.

The shape of the tubes making up the side wall is interesting, the curves on the outer and inner faces have been carefully designed to suit the different conditions of temperature, the inner ones being subject to a greater expansion are curved at a shorter radius and are so arranged as to give a flexibility within themselves, which is capable of taking up all local expansion and not setting up any strains in the connections or having any effect upon the

flue sheet. The outer face is curved at a larger radius, giving an increased stiffness and strength. These tubes are formed from commercial seamless tubing, in which a particularly high quality material, permitting very thin metal being used, can be obtained.

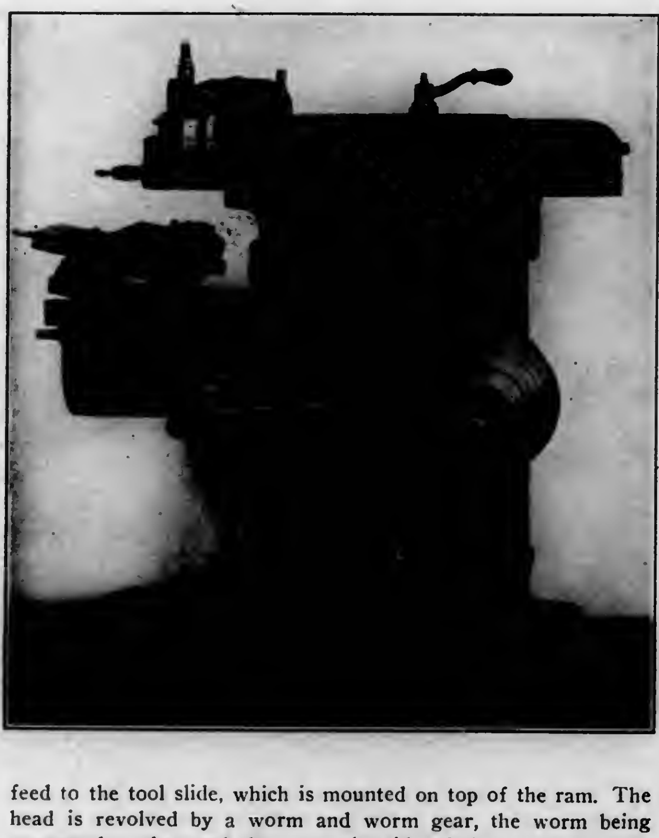
The advantages which this form of fire box seem to offer are, the more rapid, positive and efficient circulation found in water tube boilers; the shape of the side sections taking up the expansion strains and largely reducing flue and mud ring leakage; the entire elimination of staybolts, with its many advantages; the taking of all rivets or caulked joints and seams away from the fire, and the possibility of renewing damaged sections without renewing the whole side sheet and the increased safety from explosion dependent upon these features.

It is expected that a model of this boiler will be on exhibition in space 526 at the coming convention.

AN INTERESTING UNIVERSAL SHAPER

The 16-in. single geared shaper herewith illustrated has been designed by the Stockbridge Machine Company to meet conditions where a universal shaping machine that can be worked to or within limits is necessary, and it is fitted with many special attachments fitting it for practically every possible requirement of a shaper for tool room or die work.

Prominent among the special features is the power rotary



feed to the tool slide, which is mounted on top of the ram. The head is revolved by a worm and worm gear, the worm being connected to the pawl shown on the side of the ram by a train of gears. The reciprocating motion of the pawl is imparted by a dog, which is adjustable along the ram gib, and can be set to give any desired amount of throw to the pawl; the amount of throw determining the amount of feed to the worm gear. The worm can be rotated in either direction and the construction is such that when desired the head can be rotated by hand. When the rotary head is not in use it is locked to the ram by means of two bolts on either side of the head.

The head slide is provided with an automatic stop for the down feed which will be found of advantage in the duplication of parts. The stop prevents the tool from feeding down too far and spoiling the work, and it also allows the operator to attend to other work while the machine is running. An automatic feed, either up or down, is also provided for the head slide. The micrometer or down feed screw is graduated to read to .001 of an inch, and can always be set at 0. The amount of feed is regulated by the position of the dog on the ram gib. If desired, the feed to the slide can be operated by hand. The swiveling, or rotary, knee, with two working sides is revolved by the worm and worm gear through an arc of 90 degrees in either direction. One side is made to tilt for planing angles, and is especially useful in die making.

This shaper has the Stockbridge patented two-piece crank, giving a quick return of 3.5 to 1, and an even cutting speed the entire length of the cut. This quick return is maintained on short strokes, which is not possible with any other crank motion. The finished weight of the machine is 2,000 lbs. The actual length of the stroke is 16½ in.; vertical travel of the knee, 16 in.; horizontal travel of the knee, 20½ in.; ram bearing in the column, 26 in., and for key seating it takes a 3-in. shaft.

PREVENTING SCALE IN BOILERS BY AID OF ALUMINUM PLATES

A paper upon the above subject, which created considerable interest, was read at the last meeting of the New York Section of the Society of Chemical Industry by Thomas R. Duggan, of 20 Beaver street, New York.

After reviewing the necessity of a pure water for boilers and technical purposes the author went on to describe the method by which some most interesting results have been obtained in practice, and stated:

"After a long period of experimenting and after many trials, an inventor, a German scientist, Herr Brandes, discovered an apparatus—'The Luminator'—which gave to ordinary water, after simply flowing over it, certain remarkable properties. For instance, when used in steam boilers, much less scale was deposited, old scale was softened and detached from the plates, especially the flues, steam was dryer, and less coal was required in steam raising, and generally the salts were found as a powder in the bottom of the boiler, whereas otherwise they would have formed hard scale.

"The treatment consists simply of allowing water to run down an aluminum plate of special dimensions, with corrugations of a particular size, according to the character of the water to be treated.

"No chemicals are required; it is only necessary to brush well the corrugations to keep them clean and free from deposit. No scale chipping hammers are required where this apparatus is used, nor drilling machines required to drill out tubes of watertube boilers or economizers. In most cases where this method has been used the smooth and enamel-like appearance of the flue plates and surfaces has been remarked after brushing away the powder formed.

"When storage tanks and mains are far from the boiler it is necessary that they be coated with a non-conducting composition—any bituminous varnish will do—and that water reach the boiler as soon after treatment as possible. To get the maximum effect the water must be used within seven days after its treatment; hence storage tanks should not be too large. Where water is used continuously night and day, it may be found necessary to give the apparatus about one day per week rest, as the plates under certain conditions become polarized. This only happens under very unfavorable conditions, and in most cases may be neglected altogether.

"The action of the 'Luminator' is that, by the passage of water over the metal channels at certain speeds, a current of electricity is induced, the water being negative and plates positive, ionization of the salts takes place, and they do not take a crystalline form, but become amorphous; at the same time a

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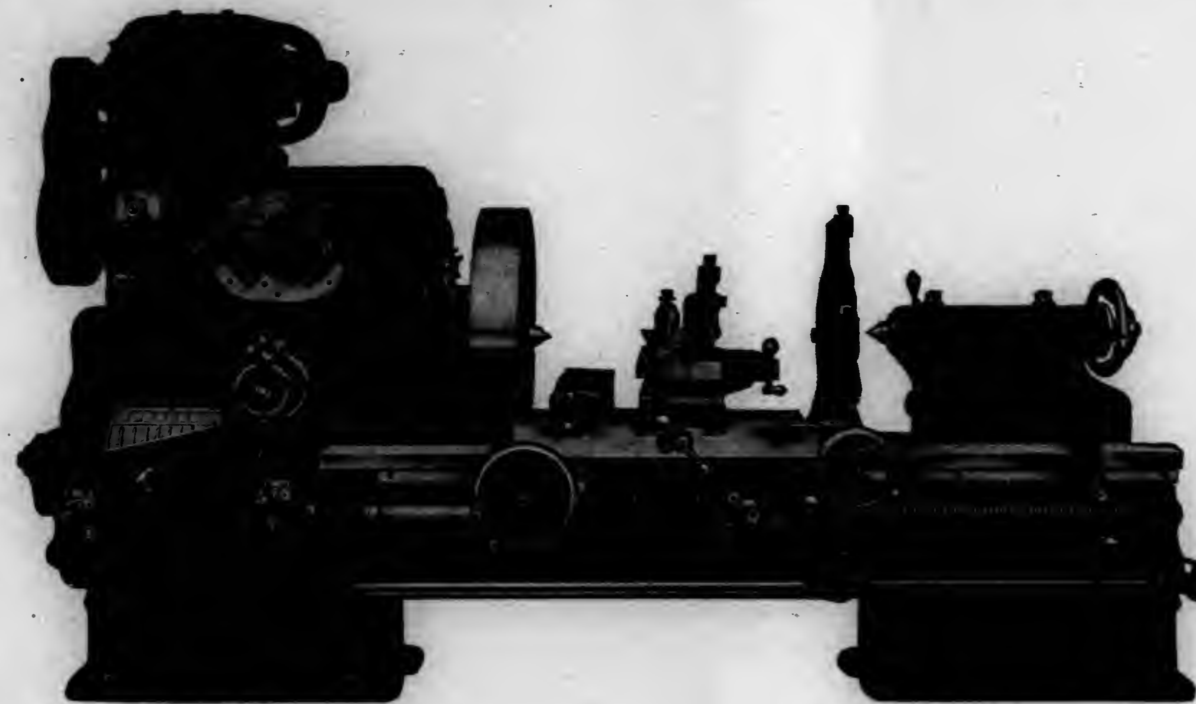

MOTOR DRIVE THROUGH "PATENTED" 12-SPEED HEAD.

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In this case the bed is of deep section, exceptionally heavy, and thoroughly braced by cross box girths at short intervals its entire length, affording a degree of rigidity sufficient to resist the heaviest cuts without vibration. The patented "drop V pattern" gives great additional swing, and permits of adding considerable metal to the depth of the carriage bridge. This insures much greater strength to resist the downward thrust of the tool than the equivalent widening of the bridge, which is commonly resorted to in the design of similar machines.

The method of motor application to these 30 and 36 in. American lathes is extremely simple and efficient, only three gears being used in connecting the armature and driving shafts. A constant speed motor, either of the direct or alternating current type, is located on top of the patented geared head, and connected to the main driving shaft through spur gearing. Twelve fundamental spindle speeds are obtainable, 6 to 275 r.p.m., and the motor is under constant control through the controller hand-wheel, which is conveniently located on the right end of the carriage. A feature in this connection quite apparent, and worthy of special mention, is the ease with which a belt driven geared head lathe can be changed to motor drive at any time after installation. A plain surface is supplied on every geared head for this purpose, and it is only necessary to apply the motor, connecting by three spur gears, armature and the drive shafts. It is also prominent that the geared head has been scientifically proportioned to resist all vibration which might originate from the motor, although it is a known fact that

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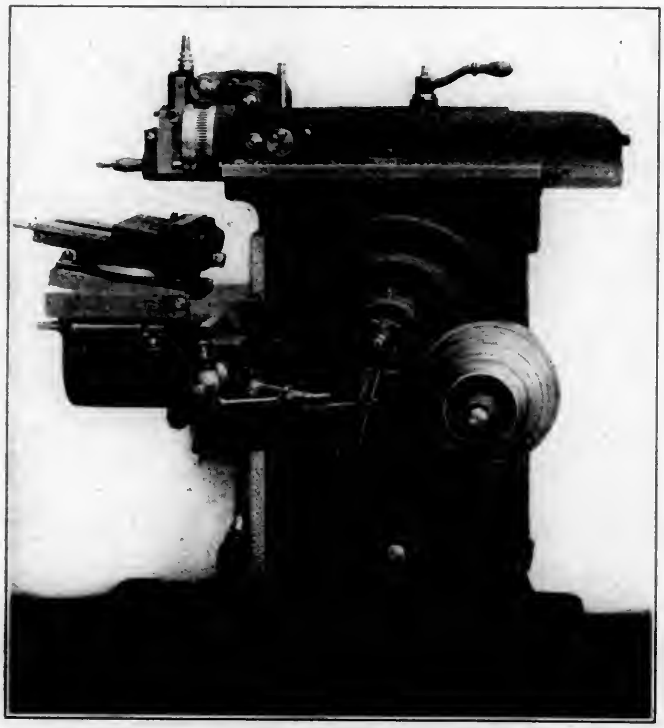

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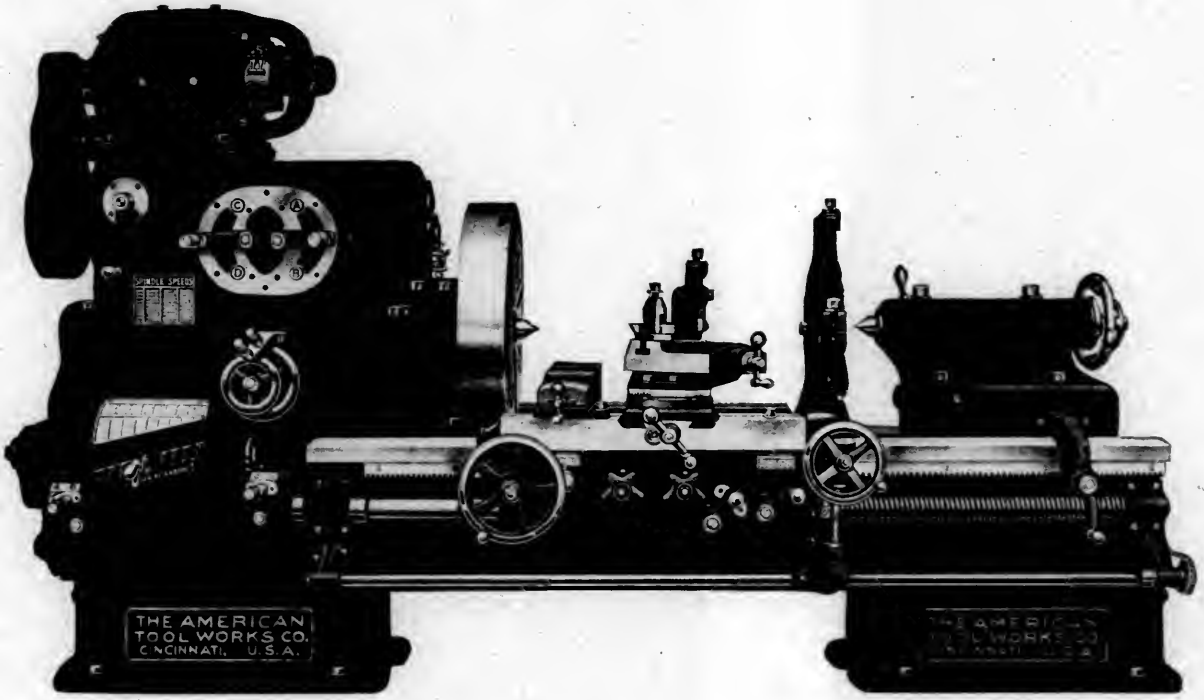

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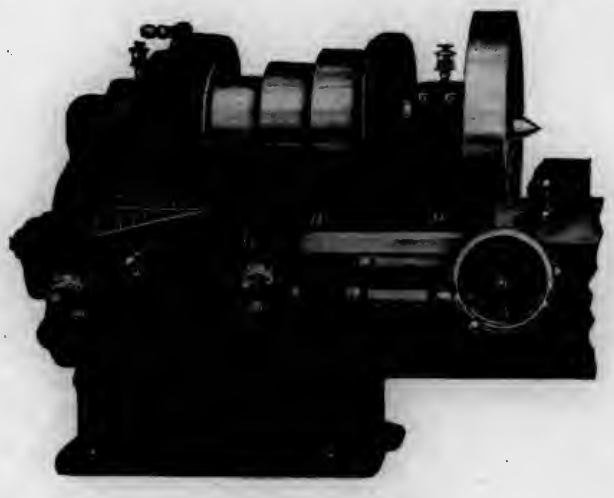
the high grade motor is such a nice mechanism that there is practically no vibration, even when running at the highest speed.

The one feature of these new lathes, which is absolutely new in design, is the quick change gear mechanism that has been developed to a degree exceeding practically all similar mechanisms. In keeping with the original lines which have been followed, representing many features of excellence, may be found all steel gears. Brown and Sharpe 20° involute cutters have been used for cutting these steel tumbler gears, and a tooth is produced pointed at the top, and unusually wide at the base. Experience has proved this style of tooth the only proper one to use in a tumbler gear constrution, as it greatly facilitates the meshing of the gears when running at high speeds, and eliminates all tendency of the gears to ride. The range of changes for feeding and screw cutting provided by this mechanism is practically unlimited. Forty-eight standard changes are shown on the index plate, listing threads from ½ to 28 threads per inch, including 11½ pipe threads, and feeds from 5 to 280 cuts per inch. The rate of feed is ten times the number of threads at the same setting. The index plate is located on the feed box directly over the sliding tumbler, and clearly shows how to obtain each thread and feed. The feed box is a complete unit, embodying what is usually carried in two sections. It consists of a gear box on the front of the bed, with two levers and a steel sliding tumbler, the latter working in conjunction with a cone of eight steel gears.

It is frequently necessary to cut odd threads, either coarse or fine, and metric pitches, on the same lathe. By means of the auxiliary quadrant and the use of special gears, any thread or feed can be obtained. Metric pitches are obtained through the English lead screw and transposing gears. This feature is of inestimable value, as it provides for all emergencies of this nature and fits the lathe for a wide range of work, from the finest threads to coarse worms.

The fundamental speed changes are made through the manipulation of the levers and handwheel on the front of the headstock. Motor speed can be comparatively high, 1,000 to 1,200 r.p.m., thereby keeping down the size and first cost of the motor. A sensitive but powerful friction clutch is provided on the driving gear for starting, stopping or slightly moving the gears in the head, to facilitate making speed changes with-



DOUBLE BACK GEARED HEAD.

out shock to the parts or interfering with the motor speed. The size of the motor is, of course, dependent upon the nature of the work to be handled. If the lathe must stand up to continuous hard work, a large motor must be used, whereas if it is intended only for a general line of work, one of normal power will be amply sufficient. The power of the motor should be from 7½ to 15 horsepower.

In addition to these special features the manner in which details have been wrought out in the construction of this machine is of exceptional interest. In particular the design of the tailstock merits a careful examination. This is representative of an extremely massive quadruple clamping stud type, with back bolts running to the top of the barrel for convenience in clamping, and it is further secured against movement by a pawl dropped into a rack cast in the center of the bed, which is exceptionally valuable when doing heavy work. This pawl can be lifted out of engagement by a pull rod on the end of the tailstock. An improved form of plug binder for clamping the spindle has a very long travel, is graduated in inches, and

12-SPEED HEAD, BELT DRIVE.

actuated by a dished handwheel which brings the wheel closer to the operator, and also secures freedom from the lost motion and back lash of the gear operated type. When the spindle is extended, it is given an extra support by a projecting nose on the tailstock, and this is further reinforced by a wide rib, extending from the tip to the base, insuring exceptional rigidity. The rack pinion can be withdrawn so that the tailstock can be removed without running it off the end of the bed.

The carriage is very heavy, especially in the bridge, where it is particularly deep, due to the drop "V" bed, and is widened to the extent dictated by good practice and judgment. The bearings are full continuous, 44 in. on the "V's," and the carriage is gibbed its full length on the back, with a clamp on each end at the front, the right hand clamp being used for binding to the bed. The lead screw is extra large, 2¾ in. diameter, and chased 1 thread per inch, permitting engagement of half nuts at any point without the use of the thread dial, except when fractional threads are desired. It is made from high carbon ground stock, chased from a Brown & Sharp master screw and carefully tested on a special apparatus built for that purpose, thus insuring a lead screw of great accuracy and long life.

Abundance of power is available in these lathes far surpassing the high efficiency of the most improved high speed steels. A minimum of power is wasted throughout the drive of the machine because of the reduction in the number of running parts, together with the most direct form of drive to the main spindle and through the feed works. This, coupled with excellent lubrication, insures the highest percentage of power delivered to the tool. Steel gears are liberally distributed throughout, wherever experience has shown them to be necessary. These are of the coarsest pitch practicable, and are cut from the solid with special cutters, no range cutters being used. All levers, handwheels and controlling mechanisms are placed conveniently for the operator, making the machine a desirable tool to handle. This feature is of particular value on a lathe of this size, where expensive work is being machined and every delay costs money.

OPERATIONS AND TIME REQUIRED FOR MACHINING A 21¼″ PISTON ON A 36″ VERTICAL TURRET LATHE

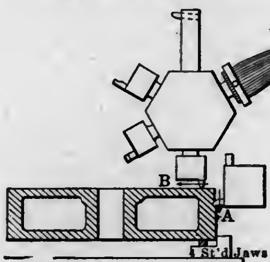
	Item	Surface Machined	OPERATIONS		Depth of Cut	Feed Per Rev.	Rev. Per Min.	Minutes Each Operation	Minutes Required Actual
Setting No. 1	1	....	Chuck Work					4	4
	2	A	One Tool, 6½″ Length of Cut	Simultaneous Cuts.	1/8″	1/12	6	6½	
	3	B	One Tool, 9″ Length of Cut		1/8″	1/12	6	9½	9½″
	4	C	One Tool, 9″ Length of Cut	Simultaneous Cuts	1/64″	1/3	6	2½	
	5	D	One Tool, 1″x1″ Groove			1/36	6	11	11
	6	E	One Tool, ¾″x2″ Cut		¾″	1/24	6	3	
	7	F	One Tool, 1″x1″ Groove			1/36	6	11	11
	8	....	Remove Piston					2	2
Setting No. 2	9	....	Chuck Work					4½	4½
	10	G	Set Tool and Finish	Speed up to 34 Rev. after H, I and J are finished. These operations performed while boring "G"	5/16″	1/12	6	20	
	11	H	" " " "		1/8″	1/12	6	1	20
	12	I	" " " "		1/8″	1/12	6	8	
	13	J	" " " "		1/64″	1/3	6 & 20	1¼	
	14	K	Ream					2	2
	15	L	Fillet					½	½
						TOTAL		86¾	64½

Piston in Rough, 21¼″x7″, weight, 410 lbs.
Piston When Finished, 21″x6¾″ weight, 337 lbs.
Metal Removed, 73 lbs.
Kind of Metal, Hunt-Spiller Metal. Time consumed in Machining Six Pistons, from floor to floor was 8 hours and 10 minutes, including oiling machine, grinding and setting tools and absence from machine that occurs during day's work, average per piston, 81⅔ minutes.

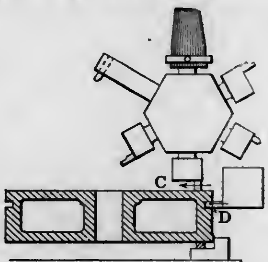
RAPID PISTON HEAD MACHINING

In the January, 1910, issue of this journal an illustrated article describing the operations required for machining a locomotive piston on a 36 in. Bullard vertical turret lathe attracted considerable attention in view of the table in connection therewith which graphically portrayed the quick time made in connection with the various detail operations. By using the vertical turret head and the side head simultaneously the total time in the table referred to was shown to be 90 minutes, a gain of 30 minutes over the two hours actually allowed by the time study.

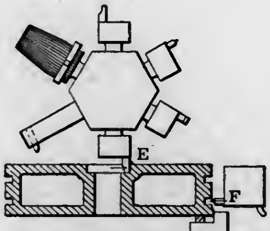
Since this was published it occurred to the master mechanic



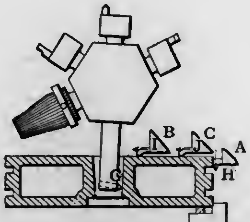
1st Setting, 1st Operation.



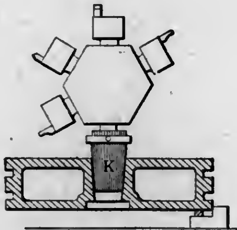
1st Setting, 2nd Operation.



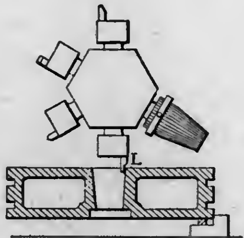
1st Setting, 3rd Operation.



2nd Setting, 1st Operation.



2nd Setting, 2nd Operation.



2nd Setting, 3rd Operation.

of a prominent Southern road that it would be a good idea to determine whether or not he was getting an output from his Bullard machines at least equal to that given in the above quoted record. The result of his efforts is clearly portrayed in the attached working table, which indicates that it is possible to machine the piston head in considerably less time than given.

These figures are very interesting, as they illustrate the wonderful possibilities of the vertical turret lathe when carefully studied and intelligently handled. It will be noted that if each operation had been performed singly it would require 86¾ minutes to complete a piston, but as some of them were done simultaneously, the time was reduced to the remarkable record of 64½ minutes actual time, or, in other words, the head was completed from floor to floor in 64½ minutes. In a striking test made of the average daily output, 6 pistons from floor to floor, were finished in 8 hours and 10 minutes. This included oiling the machine, grinding and setting tools, and absence from the machine which occurs during a day's work. The average time per piston was 81⅔ minutes. This data was taken after the test was made without the workman having any knowledge of it in order that the output under normal conditions might be determined.

RELIABLE ELECTRICAL OPERATION

It has been unofficially stated several times recently that the New York, New Haven & Hartford had practically no motive power delays in handling the entire passenger traffic of its New York end by Westinghouse electric locomotives and multiple unit trains, notwithstanding the change over from steam to electricity at Stamford. From reports of train operations in New York State during January, recently given out by the Public Service Commission, it appears that the New York, New Haven & Hartford made the best showing of any road in the state with 90 per cent. of its trains on time.

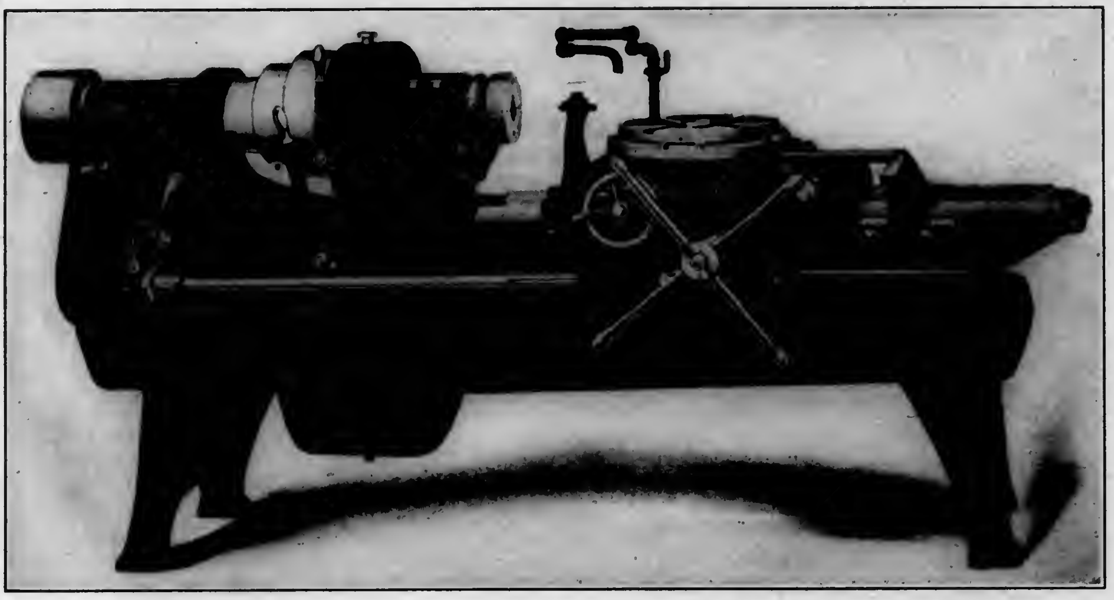
The report is especially interesting in view of the fact that the New Haven is extending its single phase electrification to the Harlem division and another branch, and reported as planning extension to New Haven. Of the roads entering New York City it is noteworthy that three of the electrically equipped roads, namely, the New Haven, Long Island and Pennsylvania, stand high with 90, 86 and 84 per cent., respectively.

"THE STRENGTH OF OXY-ACETYLENE WELDS IN STEEL," by Herbert L. Whittemore, has just been issued as Bulletin No. 45 of the Engineering Experiment Station of the University of Illinois. This bulletin gives the results of an extensive series of tests to determine the strength which may be developed in welded joints made by fusing thin steel plates together by means of the flame of an oxy-acetylene blowpipe. It was found that with careful manipulation such a welded joint may be expected to have about 85 per cent. of the strength of the plate material. Considerable information as to methods of manipulation of the oxy-acetylene blowpipe and the proper regulation of the gases is also given in the bulletin. Copies of Bulletin No. 45 may be obtained gratis upon application to W. F. M. Goss, University of Illinois, Urbana, Illinois.

ACME 2¼"x26" COMBINATION TURRET LATHE

The turret lathe owes its origin almost entirely to American invention. The earliest machines were made for the manufacture of the parts of sewing machines and small arms, and the latest and finest developments have been brought about by the bicycle and motor car industries. With all of the obvious and practical advantages of these machines for reducing the cost of production, it was not until about the year 1890 that they came into use for general manufacturing.

The chuck is specially designed to insure holding the work accurately, together with great gripping power. It is opened and closed while the machine is running by means of the long lever shown at the front of the head, and this lever also operates the roller feed. The important features of this chuck are that the work does not have "end motion" when the chuck is closed, making it possible to do second operation work requiring exact shoulder length, and the jaws do not "overhang," allowing short work to be gripped without tilting the jaws. These latter are easily removed and inserted without dismantling the chuck. A roller feed of improved type is used to feed the stock, and the centering jaws and rolls are operated together automatically. In adjusting the roller feed for any size stock, it is only necessary to turn the spanner wrench until the jaws grip the stock, then loosen a trifle and the rolls will be under the proper tension to feed the stock. Any section of bar can be fed, round, square or hexagon. Three roller rest



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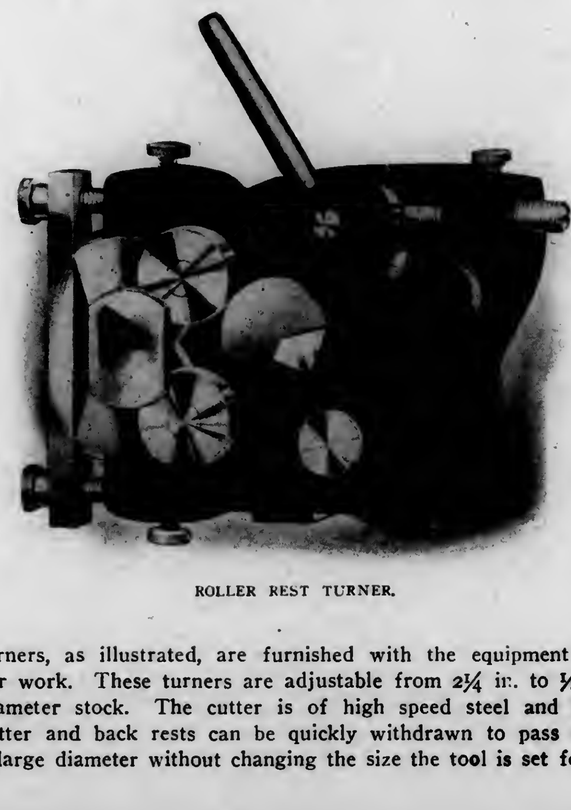
Since that time there have been many fine examples of design in the production of this indispensable tool, and manufacturers of lathes especially in this country have vied with one another to produce a machine which would in every way fulfil the requirements of stability and all-around adaptability. This healthy competition has necessarily resulted in a very high turret lathe development and a remarkable increase in efficiency and operating range.

A prominent recent output in this line, designed for great range and for adaptability in producing work from bar stock, and also from forgings and castings, using simple tools, is the 2¼ in. by 26 in. combination turret lathe by the Acme Machine Tool Co., of Cincinnati, O., which is herein illustrated. As its designation indicates, this machine handles bar work up to 2¼ in. diameter and 26 in. long, with the bar outfit of tools, also forgings and castings to 12 in. diameter, with the chucking outfit. The lathe will swing 19 in. diameter.

There are many points of superior merit embodied in this machine, the majority of which are plainly apparent in the illustration. In particular the design of the bed, which rests on three points, avoiding all twisting action, merits particular attention, as does also construction of the head which is cast solid with the bed, thus insuring great rigidity, and it is provided with friction back gears and three step cones for 3½ in. belt. The spindle is of high carbon hammered crucible steel, and all bearings are ground and hand scraped. The chip pan is made deep, to provide for holding a large quantity of chips. The oil tank is cast solid with the pan and has a perforated cover which serves as a strainer, allowing the oil to drain back into the tank. The oil pump delivers an ample supply of oil and operates when the machine is running in either direction.

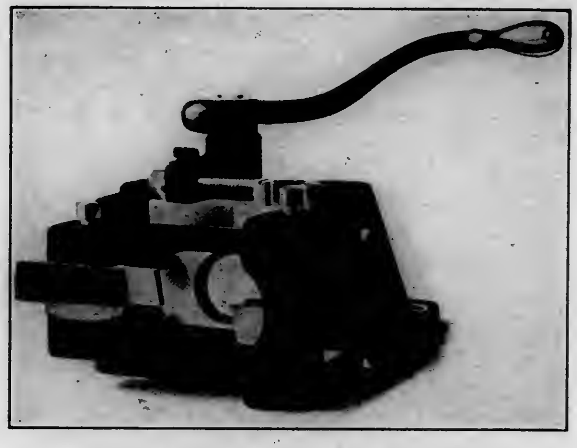
The carriage has bearings the full length on the V's, which are of large proportions, and is held securely by gibs at the front and back. Automatic adjustable stops are provided for each turret hole, and four auxiliary stops which may be used in any combination desired, are controlled by the knob seen at the right hand end of the carriage. All of the stops trip the automatic feed.



ROLLER REST TURNER.

turners, as illustrated, are furnished with the equipment for bar work. These turners are adjustable from 2¼ in. to ½ in. diameter stock. The cutter is of high speed steel and both cutter and back rests can be quickly withdrawn to pass over a large diameter without changing the size the tool is set for.

The turret consists of a circular plate with radial locating slots for the tools, also bolt holes for clamping them to the top of the turret. It is mounted on a cross slide of generous proportions. The turret locking bolt is placed at the front end of the slide directly under the cutting tool, and works in hardened and ground taper bushings let into the solid turret. This construction has been adopted as giving the most rigid tool support, the pressure of the cut being downward, resulting in a support which is practically solid. The cross slide moves on a narrow dove-tail guide with a gib for taking up wear, and



THE SLIDE TOOL.

has hand and power cross feed in both directions, with large micrometer dial. Independent micrometer stops are provided for each tool on the turret. These stops are convenient to the operator; they can be used in any combination desired, and are arranged to trip the automatic feed. A very rigid stop is used to locate the turret in its central position, all movement of the cross slide being from the center out. Power feed is provided for both the cross and longitudinal movement of the turret. It is of the geared type, giving four changes, which are instantly obtainable by moving the lever shown at the front of the head. Both feeds are reversible by means of the lever at the front of the feed box.

The slide tool, also illustrated, for holding cutting off and forming tools, will be found very convenient. The cutting off tool is placed at the rear as shown, so that the machine need not be reversed to use either tool. All working parts of the machine are carefully protected from dirt and chips, thus insuring accuracy in the output. The floor space is 3 ft. by 9 ft. 3 in., and the net weight is 3,800 lbs.

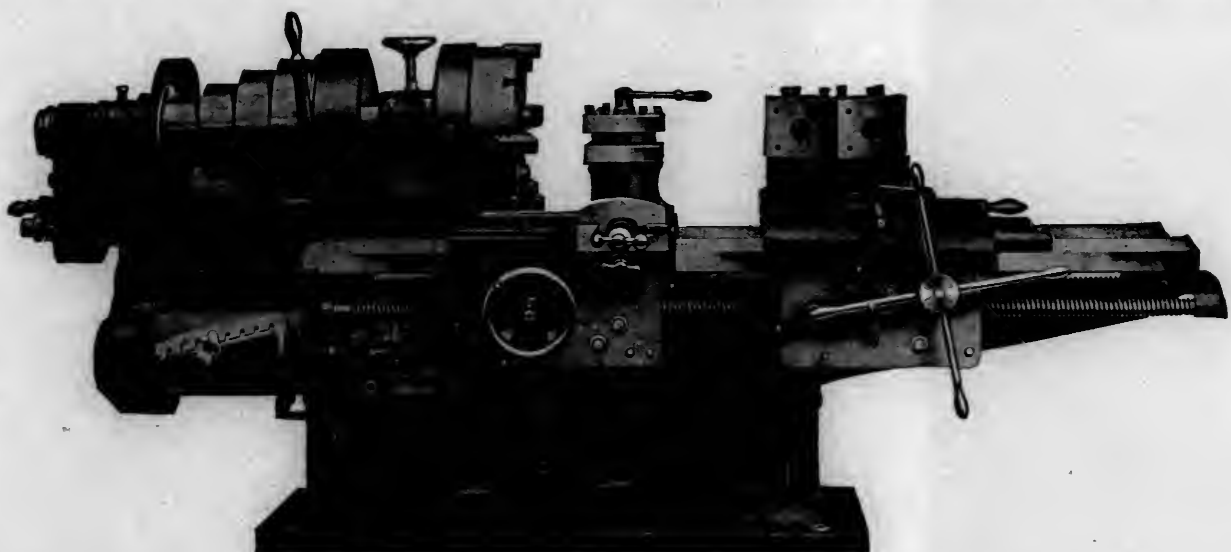
TURRET BORING, FORMING AND TURNING LATHE

As an example of a remarkably efficient turret boring, forming and turning lathe, the new machine by the W. P. Davis Machine Co., of Rochester, New York, claims particular attention. It embodies many interesting features and finely wrought details which easily place it in the front rank of the prominent machine tools of the year.

This lathe has a geared friction head and has positive drive with the back gears. The triple gear meshes into the face plate when desired. The spindle is made of special steel and has a special 18 in. 4-jaw independent chuck. The cone has four steps, and this in connection with the two-speed countershaft and the back gears gives a wide range of speeds and feeds. A change from one feed to another or a change in threads is permitted almost instantly by the quick change gear box. There are 32 changes possible, ranging from 2 to 32 threads per inch, and special or fractional threads may be cut by changing the end gears. The index plate is so simple that it can be operated without trouble or mistakes.

The saddle on which the turret is mounted is of exceptionally rigid and substantial construction. It is 25 in. wide, has a bearing of 30 inches on the bed, and a travel of 40 in. The hand feed is operated by a pilot wheel and the saddle is also supplied with power feed, having 16 instantaneous changes, and reversible by means of a foot lever on the front of the machine. This can be used for thread cutting. The turret is 15 in. from face to face, 6 in. high and has 6 faces, 6 x 8½ in., with holes 2½ in. diameter. The faces have four holes for attaching forming tools and are made with a key seat and key to prevent boring bars from turning. The turret has a locking device for holding the various faces in line with the spindle, and an open center allows the mandrel to be passed entirely through. An automatic stop is provided for each face, and any face can be tripped at any point desired on the length of the bed.

Hand and power feed are provided for the carriage, and an automatic stop for the longitudinal feed. The four-sided tool post, which can be revolved so that four different tools can be used without changing, is mounted on a cross slide of the carriage, and is supplied with power cross feed. Both the carriage and turret saddle are driven by a lead screw, so that either may be used for thread cutting.



Special attention has been paid to all minor details in the design. The boxes are made of the best quality of genuine babbit, compressed and bored, and have ample oiling facilities. The countershaft has two friction pulleys which are dust proof and self-oiling, as are also the hangers, with a bushing containing a recess for oil. The floor space occupied is 48 x 144 in. and the net weight 7,000 lbs.

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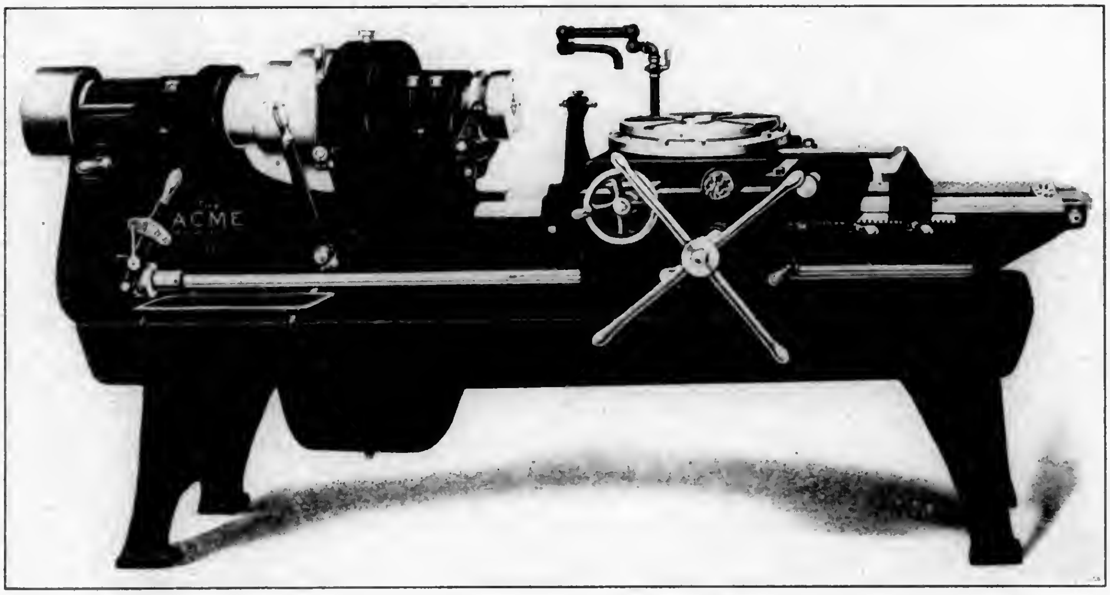

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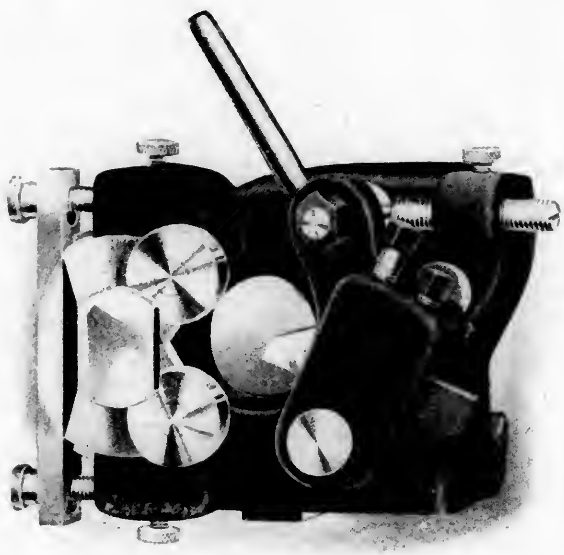

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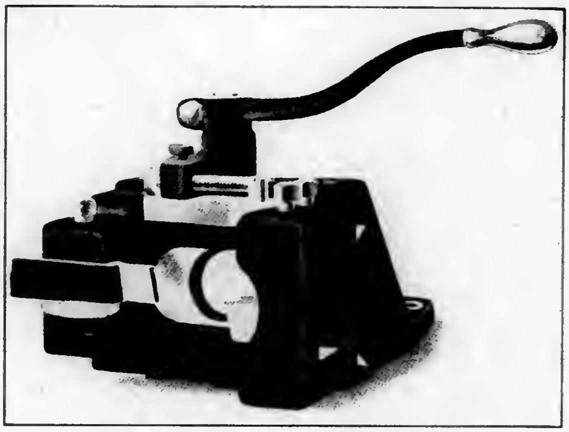

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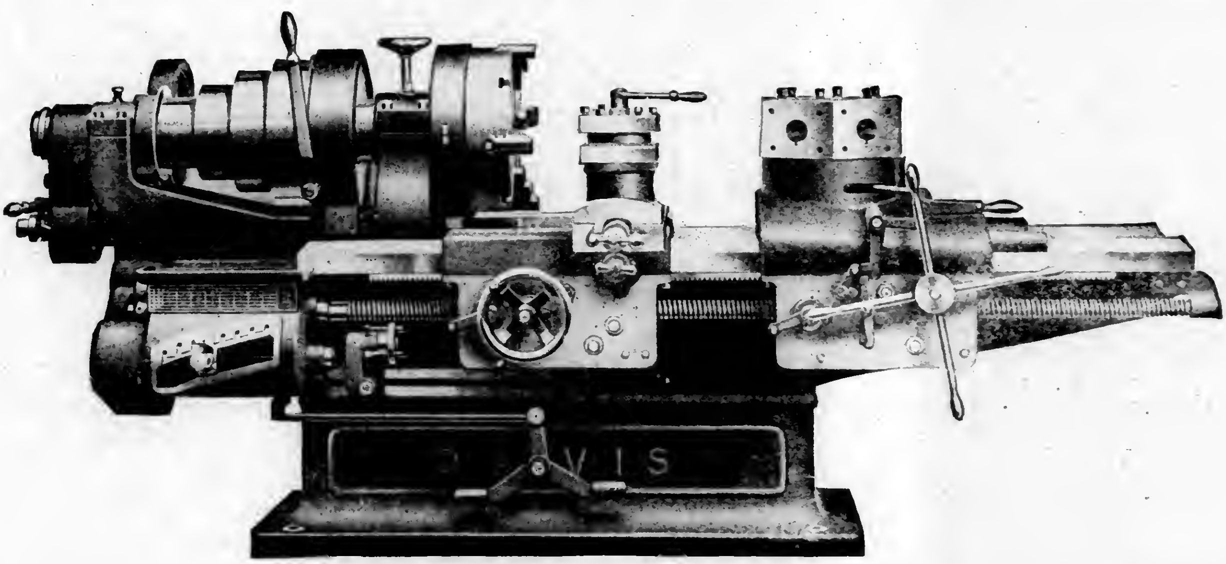


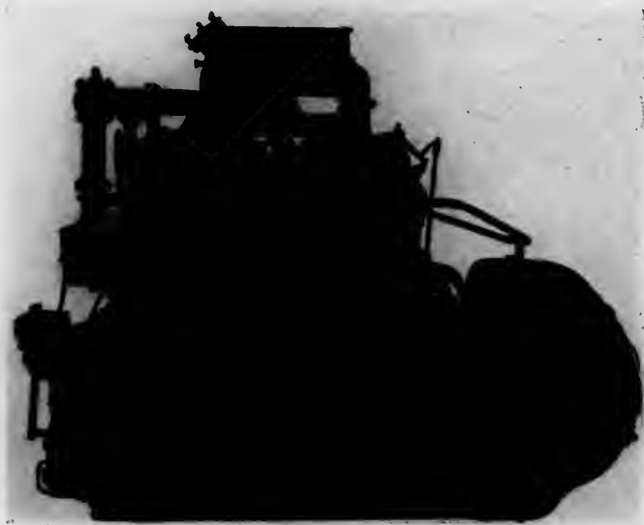
GAS-ELECTRIC MOTOR CAR

BUFFALO, ROCHESTER & PITTSBURG RY.

For several years the General Electric Company has been actively engaged in the development of the gas-electric motor car, which in its present perfected form is herewith illustrated. As no mechanical transmission exists between the engine and the axle the gas engine may be operated at its maximum efficiency without reference to the speed of the car. The electric power generated by the engine is applied to standard railway motors and operation is by means of a suitable controller in a manner similar to the practice followed in ordinary electric trolley cars. The entire arrangement of mechanism in its engine compartment constitutes a remarkable illustration of a complete and exceedingly compact power plant.

A storage tank of 100 gallons capacity supplies sufficient gasoline to carry the car over 200 miles. On its trip of delivery to the Buffalo, Rochester and Pittsburg Railway the trip of 244 miles from Schenectady to Rochester, via the Auburn division, was made on time at every point, and without delay of any kind. The smoothness of operation and easy control were subjects of the most favorable comment by the party of prominent officials of the New York Central lines who made the trip, and the speed attained on the heavy grades of the Auburn road were highly satisfactory.

The car is 66 ft. long, 14 ft. 1 in. high, and has a seating capacity of 49 in the passenger compartment and 20 in the smoking compartment, with two passengers per seat. The seats are sufficiently wide to accommodate three persons, if desired, and under such arrangement the passenger compartment will accommodate 69, and the smoking compartment 28. It will be noted in the design that the side door construction has been embodied which permits an exceedingly handsome observation end which is also encircled by a continuous seat. Automatic and straight air brakes are provided in addition to the auxiliary hand brake in case of emergencies. The car is also equipped with standard automatic air signals.



GAS ENGINE GENERATING SET.

PASSENGER COMPARTMENT, LOOKING FORWARD.

EDITOR'S NOTE.—For other motor car articles in this journal, see the following references:

Beach Storage Battery Car	April, 1911, p. 150
Gas-Electric Motor Car, General Electric Co	Feb., 1910, p. 66
Gasolene Motor Car, Fairbanks, Morse & Co	Nov., 1909, p. 460
Steam Motor Car, Am. Loco. Co	Aug., 1908, p. 293
Strang Gas-Electric Motor Car	July, 1908, p. 256
Ganz Steam Motor Car, Intercolonial Ry	Nov., 1907, p. 445
Ganz Steam Motor Car, Erie R. R	Aug., 1907, p. 312
Steam Motor Car, Canadian Pacific Ry	Sept., 1906, p. 333
Steam Motor Car, Canadian Pacific Ry	Aug., 1906, p. 294
Union Pacific R. R., Gasolene Motor Car	May, 1906, p. 187

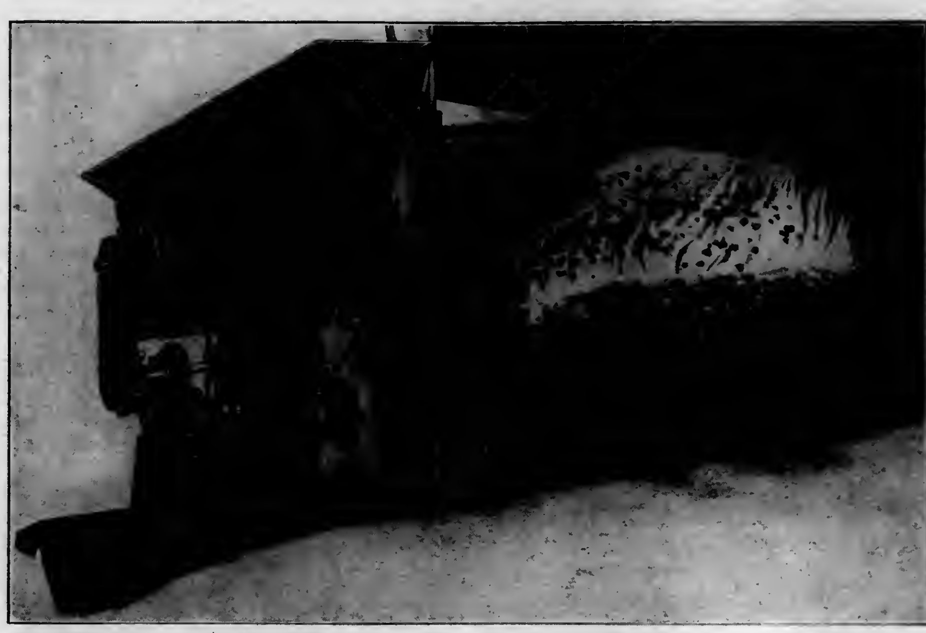
STEEL UNDER BODIES FOR MAIL CARS.—Railway post-office cars with all-steel under-frames will be required by the Post-Office Department after July 1. This arrangement was effected at a conference between Postmaster-General Hitchcock and a delegation of railroad officials. It was agreed that the proposed construction was the best to be used in the period of transition between the all-wood and the all-steel railway mail car.

A PROPOSITION TO INVEST ONE DOLLAR to save ten is frequently less attractive than a proposition to invest ten dollars to save one, because it is unconventional.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE "ERIE" STOKER

The stoker shown in the illustration is a self-contained machine, complete in itself, without any auxiliary apparatus, and is particularly applicable to stationary boilers rated up to 250 h.p. and to small and medium size power plants. It is of the overfeed plunger type and is applied to the exterior of the boiler, not interfering with the existing conditions within the firebox.

This stoker consists of the following essential parts: A coal hopper with opening in the bottom at the end nearest the boiler; a conveyor for agitating or carrying the coal from the rear of the hopper to the opening at the front of the hopper, where it falls by gravity in front of the plunger, thus assuring a uniform delivery of fuel, and a main cylinder and trough in which reciprocates a piston and plunger, which, with a variable stroke, throw the coal to the different parts of the firebox. This variable stroke is given to the plunger by means of a rotary valve, two separate steam ports leading from this valve to the rear end of the cylinder, and two choke plugs, one from each of the steam ports. The office of the two choke plugs is to vary the amount of steam reaching the rear end of the cylinder through the various ports, and thereby give a variable stroke to the plunger. The valve operates in a rotary manner, each of the ports stopping full open in front of its corresponding steam passage in regular succession. The conveyor is controlled by a small reciprocating steam motor which also operates the valve that controls the speed of the piston or plunger, thus giving a uniform amount of coal for each stroke of the plunger. The deflector which is attached to the front of the trough is so designed as to spread the coal to the sides of the furnace as it is delivered by the plunger. The exhaust steam from the motor passes over the deflector, thus assisting the distribution of the coal to the front corners of the firebox. This combination of deflector and exhaust steam absolutely assures even distribution of the coal over the entire grate surface. Each stoker is equipped with an automatic regulator which maintains a constant steam pressure by regulating the amount of coal fed, thus effecting a great saving in fuel.



No portion of the stoker is exposed to the effects of the heat and it is particularly to be noted that the stoker is located between the two fire doors and consequently if there is a breakdown it is a simple matter to hand fire until it is fixed. As a matter of fact, however, the stoker is so extremely simple in its method of construction that the probability of a breakdown is very remote.

It is the ultimate purpose of the Erie Foundry Co., Erie, Pa., to re-design this stoker with a view to adapting it to locomotive practice, but the demand for stationary boilers has been so large that the development of the locomotive type has necessarily been postponed.

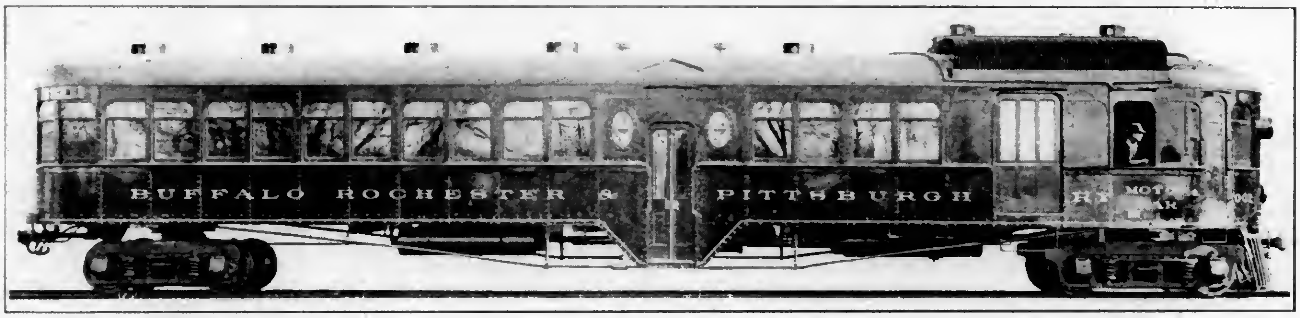
OILDAG

Graphite has always been recognized as possessing great merit as a lubricant, but much difficulty has been experienced in arranging for a suitable carrier to get it positively and properly to the bearing surface since ordinary graphite will not remain in suspension in any of the good lubricants. Dr. Edward G. Acheson, however, has finally been successful in solving the problem and has been able to produce a deflocculated graphite which will remain in suspension in oil for any length of time. This mixture has been given the name of "Oildag."

In making this deflocculated graphite an electric furnace is employed and the process is carried on at a temperature which vaporizes every impurity, leaving entirely pure graphite. The particles of graphite resulting are so fine as to be invisible to the naked eye and it is stated that it would take 125,000 of them placed side by side to reach an inch. It will pass through the finest filter paper. This material is mixed with a high grade oil and proves practically a perfect lubricant, not being subject to evaporation or oxidizatoin. It is claimed that one gallon of this material will easily do the work of three gallons of oil and that in two large power stations in New York City the consumption of cylinder oil has been reduced more than 60 per cent. through the use of "Oildag." It would appear that this lubricant is one unusually well suited for locomotives and cars, particularly in view of the well-known effect of graphite on bearing surfaces in giving them a very high polish and almost self-lubricating qualities.

This material is being handled by the International Acheson Graphite Co., Niagara Falls, N. Y.

TO REMOVE PAINT FROM IRON, take lime and mix with common lye into a thick paste by the addition of water, and apply over the surface with a mason's trowel to a thickness of about ⅛ in. After allowing the mixture to remain a short time, wash off with a hose, and most of the old paint will be entirely removed, the remainder being easily scraped off. If the iron has several coats of dried paint, two or three applications will be necessary before the entire surface is clean.



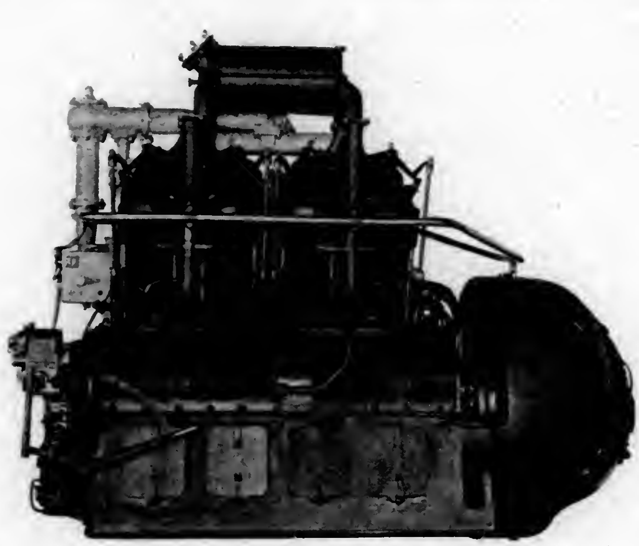
GAS-ELECTRIC MOTOR CAR

BUFFALO, ROCHESTER & PITTSBURG RY.

For several years the General Electric Company has been actively engaged in the development of the gas-electric motor car, which in its present perfected form is herewith illustrated. As no mechanical transmission exists between the engine and the axle the gas engine may be operated at its maximum efficiency without reference to the speed of the car. The electric power generated by the engine is applied to standard railway motors and operation is by means of a suitable controller in a manner similar to the practice followed in ordinary electric trolley cars. The entire arrangement of mechanism in its engine compartment constitutes a remarkable illustration of a complete and exceedingly compact power plant.

A storage tank of 100 gallons capacity supplies sufficient gasoline to carry the car over 200 miles. On its trip of delivery to the Buffalo, Rochester and Pittsburg Railway the trip of 244 miles from Schenectady to Rochester, via the Auburn division, was made on time at every point, and without delay of any kind. The smoothness of operation and easy control were subjects of the most favorable comment by the party of prominent officials of the New York Central lines who made the trip, and the speed attained on the heavy grades of the Auburn road were highly satisfactory.

The car is 66 ft. long, 14 ft. 1 in. high, and has a seating capacity of 49 in the passenger compartment and 20 in the smoking compartment, with two passengers per seat. The seats are sufficiently wide to accommodate three persons, if desired, and under such arrangement the passenger compartment will accommodate 69, and the smoking compartment 28. It will be noted in the design that the side door construction has been embodied which permits an exceedingly handsome observation end which is also encircled by a continuous seat. Automatic and straight air brakes are provided in addition to the auxiliary hand brake in case of emergencies. The car is also equipped with standard automatic air signals.



GAS ENGINE GENERATING SET.

PASSENGER COMPARTMENT, LOOKING FORWARD.

Editor's Note.—For other motor car articles in this journal, see the following references:

Beach Storage Battery Car	April, 1911, p. 150
Gas-Electric Motor Car, General Electric Co	Feb., 1910, p. 66
Gasolene Motor Car, Fairbanks, Morse & Co	Nov., 1909, p. 460
Steam Motor Car, Am. Loco. Co	Aug., 1908, p. 293
Strang Gas-Electric Motor Car	July, 1908, p. 256
Ganz Steam Motor Car, Intercolonial Ry	Nov., 1907, p. 415
Ganz Steam Motor Car, Erie R. R	Aug., 1907, p. 312
Steam Motor Car, Canadian Pacific Ry	Sept., 1906, p. 333
Steam Motor Car, Canadian Pacific Ry	Aug., 1906, p. 294
Union Pacific R. R., Gasolene Motor Car	May, 1906, p. 187

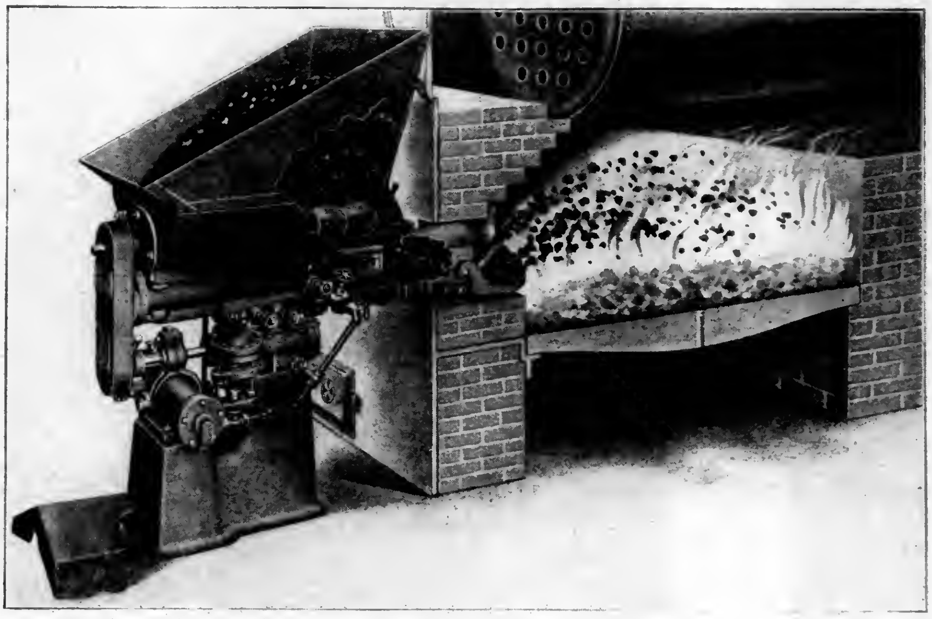
Steel Under Bodies for Mail Cars.—Railway post-office cars with all-steel under-frames will be required by the Post-Office Department after July 1. This arrangement was effected at a conference between Postmaster General Hitchcock and a delegation of railroad officials. It was agreed that the proposed construction was the best to be used in the period of transition between the all-wood and the all-steel railway mail car.

A Proposition to Invest One Dollar to save ten is frequently less attractive than a proposition to invest ten dollars to save one, because it is unconventional.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE "ERIE" STOKER

The stoker shown in the illustration is a self-contained machine, complete in itself, without any auxiliary apparatus, and is particularly applicable to stationary boilers rated up to 250 h.p. and to small and medium size power plants. It is of the overfeed plunger type and is applied to the exterior of the boiler, not interfering with the existing conditions within the firebox.

This stoker consists of the following essential parts: A coal hopper with opening in the bottom at the end nearest the boiler; a conveyor for agitating or carrying the coal from the rear of the hopper to the opening at the front of the hopper, where it falls by gravity in front of the plunger, thus assuring a uniform delivery of fuel, and a main cylinder and trough in which reciprocates a piston and plunger, which, with a variable stroke, throw the coal to the different parts of the firebox. This variable stroke is given to the plunger by means of a rotary valve, two separate steam ports leading from this valve to the rear end of the cylinder, and two choke plugs, one from each of the steam ports. The office of the two choke plugs is to vary the amount of steam reaching the rear end of the cylinder through the various ports, and thereby give a variable stroke to the plunger. The valve operates in a rotary manner, each of the ports stopping full open in front of its corresponding steam passage in regular succession. The conveyor is controlled by a small reciprocating steam motor which also operates the valve that controls the speed of the piston or plunger, thus giving a uniform amount of coal for each stroke of the plunger. The deflector which is attached to the front of the trough is so designed as to spread the coal to the sides of the furnace as it is delivered by the plunger. The exhaust steam from the motor passes over the deflector, thus assisting the distribution of the coal to the front corners of the firebox. This combination of deflector and exhaust steam absolutely assures even distribution of the coal over the entire grate surface. Each stoker is equipped with an automatic regulator which maintains a constant steam pressure by regulating the amount of coal fed, thus effecting a great saving in fuel.



No portion of the stoker is exposed to the effects of the heat and it is particularly to be noted that the stoker is located between the two fire doors and consequently if there is a breakdown it is a simple matter to hand fire until it is fixed. As a matter of fact, however, the stoker is so extremely simple in its method of construction that the probability of a breakdown is very remote.

It is the ultimate purpose of the Erie Foundry Co., Erie, Pa., to re-design this stoker with a view to adapting it to locomotive practice, but the demand for stationary boilers has been so large that the development of the locomotive type has necessarily been postponed.

OILDAG

Graphite has always been recognized as possessing great merit as a lubricant, but much difficulty has been experienced in arranging for a suitable carrier to get it positively and properly to the bearing surface since ordinary graphite will not remain in suspension in any of the good lubricants. Dr. Edward G Acheson, however, has finally been successful in solving the problem and has been able to produce a deflocculated graphite which will remain in suspension in oil for any length of time This mixture has been given the name of "Oildag."

In making this deflocculated graphite an electric furnace is employed and the process is carried on at a temperature which vaporizes every impurity, leaving entirely pure graphite. The particles of graphite resulting are so fine as to be invisible to the naked eye and it is stated that it would take 125,000 of them placed side by side to reach an inch. It will pass through the finest filter paper. This material is mixed with a high grade oil and proves practically a perfect lubricant, not being subject to evaporation or oxidizatoin. It is claimed that one gallon of this material will easily do the work of three gallons of oil and that in two large power stations in New York City the consumption of cylinder oil has been reduced more than 60 per cent. through the use of "Oildag." It would appear that this lubricant is one unusually well suited for locomotives and cars, particularly in view of the well-known effect of graphite on bearing surfaces in giving them a very high polish and almost self-lubricating qualities.

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MEN WANTED

Car Draftsman.—On eastern railroad, experienced draftsman for work on steel passenger and freight car design. Address M. R. W., care American Engineer.

Car Draftsman.—Must be experienced in general car design and in detail work. Location in eastern city. Address L. J., care American Engineer.

POSITIONS WANTED

A Graduate from a leading technical college, having degrees in both mechanical and electrical engineering, has completed four years' apprenticeship in machine shop and two years as machinist in locomotive repair shops and desires any engineering position offering advancement. Age 26. Can furnish substantial references. Address J. S. T., care American Engineer.

Supt. of Construction, Installation Engineer, Engineering Salesman, Inspector.—Graduate in mechanical engineering, later special student in electrical engineering; over ten years' experience, East and West; railroad work, from shops to Assistant Engineer; experience with large engineering works and with consulting engineers. Installation, erecting, testing of machinery; steam or hydro-electric power plants, shops and mills, electric traction, irrigation pumping plants. Plans and estimates furnished. Address H. K. J., care American Engineer.

BOOK NOTES

Principles of Scientific Management. By Frederick W. Taylor, M.E., Sc.D. 144 pages. Cloth. Published by Harper and Brothers, New York. Price, $1.50 net.

In the introduction of this work the author states that it has been written for three reasons:

First—"To point out through a series of simple illustrations the great loss which the whole country is suffering through inefficiency in almost all of our daily acts.

Second—"To try and convince the reader that the remedy for this inefficiency lies in systematic management rather than in searching for some unusual or extraordinary man.

Third—"To prove that the best management is a true science resting upon clearly defined laws, rules and principles as a foundation and, further, to show that the fundamental principles of scientific management are applicable to all kinds of human activities, from our simplest individual acts to the work of our great corporations, which call for the most elaborate co-operation and, briefly, through a series of illustrations to convince the reader that whenever these principles are correctly applied, results must follow which are truly astonishing."

If there is any one capable of clearly demonstrating the principles and practical value of scientific management it is Mr. Taylor, who is largely the originator of the idea, and who has spent over thirty years in study and practice along these lines. The results he has actually obtained under many varying conditions and in many different classes of work give him a position of authority exceeded by none. In this book he treats the subject in a very clear, interesting style, taking each phase of the general principles separately and discussing it clearly and logically, driving the points home by means of well selected, actual examples, taken from his own experience.

To any one unfamiliar with the general principles of scientific management or of Mr. Taylor's methods, this book will give a much clearer idea of the general subject than any work heretofore published, since it follows its title and deals with principles without confusing them with lengthy discussions of their application.

Heat. By J. Gordon Ogden, Ph.D. Cloth, 118 pages, 4½ x 6½. Illustrated. Published by Popular Mechanics Co., Chicago. Price, 25c.

The book consists of a series of articles, each complete in itself, yet all pertaining to heat and its relation to modern mechanics. It is one of a series of handbooks on industrial subjects being published by the above company and is "written so you can understand it." It is a valuable little treatise and may be regarded as a useful addition to any mechanical library.

Proceedings of the International Railroad Master Blacksmiths' Association. Eighteenth Annual Convention. Held at Detroit, Mich., August 16, 17 and 18, 1910. Cloth, 284 pages, 5½ x 8. Secretary, A. L. Woodworth, C. H. & D. R. R., Lima, O.

Although the papers presented at this convention were unusually brief it is quite evident that what was lost in length was more than compensated for in strength. This was well borne out by the extended discussion which followed in the instance of practically every subject presented. There is no need to add that this is exactly as it should be. The true test of the value of any convention is best determined by the interest taken by those in attendance, and their participation in the proceedings The Master Blacksmiths' Association is to be congratulated on its selection of subjects of such timely interest that comment followed as a logical result. The principal papers presented were on Tools and Formers, the Development of Railroad Frogs and Switches, High Speed Steel, Frame Making and Repairing, Oxy-Acetylene Welding, and Spring Making and Repairing. The book is complete with these valuable papers and the discussions, and is unusually well illustrated with half-tones and line drawings.

Power. By Charles E. Lucke, Ph.D. Cloth. 304 pages. 5 by 7½ inches. Illustrated. Published by the Columbia University Press, New York, N. Y.

The object of the series of lectures included in this volume is to point out the enormous effect that the substitution of mechanical power for hand and animal labor has had on the organization of society and the conditions of living, and by presenting the development of power machinery to show what sort of ideas have produced this result. The bulk of the subject matter accordingly is concerned with the apparatus and machinery for the converting of natural energy in any of its available forms into useful work, together with the physical processes for the execution of which that apparatus was devised. The book is well illustrated with over 200 half-tones and line drawings, and is extremely valuable in its historical aspect.

The Supply Department. By H. C. Pearce. Cloth. 112 pages. 5½ by 9 inches. Published by the *Railway Age Gazette*, 83 Fulton street, New York, N. Y.

This book from the pen of the general storekeeper of the Southern Pacific Co. is the first of its kind ever published, and as such will no doubt be widely read by those identified with this important branch of ralroad service. The work treats successively on purpose and organization, duties of officers, general and division stores, requisitions, handling, and all pertaining to supply department work. Several of the chapters are illustrated by organization charts, storehouse floor plans, and order, requisition and statement forms.

Scientific Management and Railroads. By Louis D. Brandeis. Cloth. 92 pages. Published by the *Engineering Magazine*, 140 Nassau street, New York, N. Y.

On January 3, 1911, Mr. Brandeis submitted to the Interstate Commerce Commission a brief in which the evidence introduced at earlier hearings on the possibilities of economies, which could be attained by the introduction of scientific management, was referred to and discussed. About one-half of the brief related

to the latter subject, and this part is now reprinted in the present volume.

Engineering Index Annual for 1910. Published by *The Engineering Magazine*, New York, N. Y. Cloth. 496 pages, 6 x 9 inches.

The present volume of this valuable publication, which is the ninth since the work was first undertaken, and the fifth since it assumed the annual form, represents the continuation of that originally started by the late Professor J. B. Johnson in the Journal of the Association of Engineering Societies in 1884, and turned over by that association to the *Engineering Magazine* at the close of 1895. Its addition to the previous volumes, published in 1892, 1896, 1901, 1906, 1907, 1908, 1909 and 1910, makes available to the reader a continuous index to the engineering and technical literature of the past twenty-six years. With each succeeding issue additional care has been exercised to meet the convenience of the users of the book, and especially to facilitate its use in libraries by those who are not accustomed to refer to it month by month, and hence are not wholly familiar with the arrangement. So well known and indispensable has this work become to engineers, superintendents and managers, that to comment on its scope and usefulness would probably be superfluous, but sufficient to say it incorporates references to practically every article of value that has appeared in any of the scientific or technical magazines during the past year. Its comprehensive scope is well indicated by the list of periodicals included. This comprises about two hundred and fifty publications, representing seventeen nations and colonies and six languages. The value of this work to the engineer who necessarily must make frequent search of the past files of technical periodicals is incalculable, and his library cannot be complete without its addition.

PERSONALS

WM. QUEENAN has been appointed car shop foreman of the Chicago, Burlington & Quincy Railroad at Aurora, Ill.

GEORGE WORLING has been appointed master mechanic of the Gainesville Midland Ry., with office at Gainesville, Ga.

GEO. DURHAM has been appointed master mechanic on the Delaware, Lackawanna & Western R. R. at Scranton, Pa.

D. M. KNOX has been appointed to succeed W. H. V. Rossing as mechanical engineer of the Missouri Pacific system.

C. E. GOSSETT has been made master mechanic of the Minneapolis & St. Louis, Ry., with headquarters at Minneapolis, Minn.

N. KIRBY has been appointed master mechanic of the Alabama, Tennessee & Northern R. R. at Panola, Ala., vice D. D. Briggs.

T. KILPATRICK has been appointed general foreman at the Cedar Rapids, Ia., shops of the Rock Island Lines, succeeding J. M. Whalen, resigned.

EDWARD HUGHES has been appointed purchasing agent of the Lehigh & New England R. R., with office at Lansford, Pa.. vice J. B. Whitehead, resigned.

W. H. SNYDER, general foreman, mechanical department, of the Tonopah & Goldfield Ry., at Goldfield, Nev., has had his title changed to master mechanic.

GEORGE MCQUAID has been made general foreman of the Chicago, Rock Island & Pacific Ry., at Eldon, Ia., vice R. J. McQuaid, transferred to Rock Island, Ill.

A. L. MCNEIL has been appointed assistant purchasing agent of the Chicago & Alton Ry., and the Toledo, St. Louis & Western R. R., with office at Chicago.

B. RICHARDSON has been made superintendent of motive power of the Duluth & Iron Range R. R., with office at Two Harbors, Minn., vice R. B. Moore.

H. D. JACKSON has been appointed master mechanic of the Charlotte Harbor & Northern Railway, with headquarters at Arcadia, Fla., vice S. B. Smith, resigned.

JOHN RYAN has been appointed superintendent of the fuel department of the Missouri, Kansas & Texas Ry., with office at Pittsburg, Kan., succeeding John Jopling, deceased.

GEORGE E. CHESSFORD has been appointed master mechanic of the Chicago, Milwaukee & Puget Sound Ry., at Miles City, Mont., succeeding A. V. Manchester, resigned.

C. J. DRURY has been made master mechanic of the Santa Fe at Amarillo, Tex., vice W. J. Hill, transferred to succeed Mr. Drury at Arkansas City, Kan., as master mechanic.

FRED RENTCHLER, formerly with the Wabash R. R. at Moberly, Mo., has been appointed general foreman of boiler work for the St. Paul & Des Moines Ry. at Des Moines, Iowa.

F. W. STUBBS succeeds John R. Thompson as mechanical engineer on the Chicago Great Western Ry. at Oelwein, Ia., Mr. Thompson having been appointed master mechanic at Clarion, Ia.

A. N. WILSIE has been appointed master mechanic of the Omaha division of the Chicago, Burlington & Quincy R. R., with headquarters at Omaha, Neb., succeeding E. D. Andrews, resigned.

W. H. V. ROSSING, mechanical engineer of the Missouri Pacific system, has been appointed assistant to Vice-President Nixon of the Frisco lines, with jurisdiction over mechanical matters.

J. M. JAMES, master mechanic at Olean, N. Y., Pennsylvania, Railroad, has been transferred in a similar capacity to West Philadelphia, Pa., succeeding J. C. Mengel, transferred to Altoona.

J. C. MENGEL, master mechanic at the West Philadelphia shop, has been transferred in a similar capacity to the Altoona machine shop, Pennsylvania Railroad, succeeding I. D. Thomas, promoted.

J. M. HENRY, master mechanic on the Pennsylvania Railroad at Sunbury, Pa., has been transferred in a similar capacity to Olean, N. Y., succeeding J. M. James, transferred to West Philadelphia, Pa.

J. B. ELLIOTT, master mechanic of the Baltimore & Ohio R. R., at Newcastle Junction, Pa., has been appointed master mechanic at the Glenwood shops, Pittsburg, succeeding J. F. Prendergast, resigned.

A. M. DARLOW, round house foreman of the Chicago & Eastern Illinois R. R., at Danville, Ill., has been appointed mechanical engineer of the Buffalo & Susquehanna Railroad, with office at Galeton, Pa.

E. E. MULLINS, mechanical engineer of the Northern Railway Company, Costa Rica, has been appointed superintendent of motive power, with office at Limon, Costa Rica, succeeding W. H. Sample, resigned.

T. F. UNDERWOOD, roundhouse foreman on the St. Louis & San Francisco Ry. at Springfield, Mo., has been transferred to Monett, and J. E. Burke of the latter point, takes Mr. Underwood's place at Springfield.

E. F. ESSICK, master mechanic of the Saginaw division of the Pere Marquette Ry., has been transferred to Ludington, Mich., and is succeeded by C. J. Shudder, who is promoted from foreman of the Saginaw shops.

S. H. DRAPER, general air brake inspector of the Northern Pacific R. R. at St. Paul, Minn., has been appointed master mechanic of the Rocky Mountain division, with office at Missoula, Mont., succeeding Silas Zwight, promoted.

E. J. MYERS has been appointed to succeed John McKeown, retired, as foreman boilermaker at the Galion, O., shop of the Erie Railroad. Mr. McKeown retires after many years' service, the greater part of which was in connection with the Galion shop.

J. LOWELL WHITE has been appointed assistant purchasing agent of the New Orleans, Texas & Mexico Ry.; the Beaumont, Sour Lake & Western R. R.; the Orange & Northwestern Ry., and the St. Louis, Brownsville & Mexico R. R., with office at Houston, Texas.

H. P. MEREDITH, assistant engineer of motive power in the office of the general superintendent of motive power, Pennsylvania Railroad, at Altoona, Pa., has been appointed master mechanic, with office at Baltimore, Md., succeeding Eliot Sumner, transferred to Sunbury, Pa.

I. D. THOMAS, master mechanic at the Altoona, Pa., machine shops of the Pennsylvania Railroad, has been promoted to superintendent of motive power of the Erie division of the Pennsylvania Railroad and the Northern Central Railway, with office at Williamsport, Pa., succeeding J. T. Wallis, promoted.

H. M. CURRY, general master mechanic of the Northern Pacific lines east of Mandan at St. Paul, Minn., has been appointed mechanical superintendent, with office at St. Paul, succeeding William Moir, retired after having been with the company for almost thirty years. Silas Zwight, master mechanic at Missoula, Mont., succeeds Mr. Curry.

CATALOGS

Freight, Baggage and Express Handling.—The Automatic Transportation Company, of Buffalo, N. Y., has published an illustrated pamphlet descriptive of its electric truck, which has been specially designed and constructed for handling package freight at railway and steamship terminals, and in fact all institutions which require trucking about the premises. The truck operated by storage batteries weighs 1,800 pounds and will carry from 2,000 to 4,000 pounds.

Gas Engines.—The Mesta horizontal double-acting four-cycle gas engine is described and illustrated in a new catalog issued by the Mesta Machine Company, of Pittsburg, Pa. This company does not build what are termed small gas engines, their smallest size being about 400 horsepower, but they turn out all sizes from that up to the largest engine used. The present catalog contains some well executed half-tones, suppelmentary to the descriptive matter, and concludes with a very interesting and instructive comparison between gas versus steam power.

Graphite Lubrication.—A booklet has just been issued by the International Graphite Company, of Niagara Falls, N. Y., which reproduces the very interesting and instructive address on the above subject which was delivered by Dr. Edward G. Acheson before the Automobile Club of America, May 17, 1910, and before the National Gas and Gasoline Engine Trades Association, Cincinnati, O., June 14, 1910. This little book is of great value to users of graphite and to those interested in the subject and it will well repay a careful perusal.

Silica-Graphite Paint.—The Josepn Dixon Crucible Company, of Jersey City, N. J., has just published a very neat folder entitled "Maintenance Painting for Electric Railways." It gives excellent photographs of street railway viaducts, power plant stacks, and car trucks painted with Dixon's silica-graphite paint. The folder explains in a very interesting way the special adaptability of this paint for street railway uses, and the Paint Department of that company will be glad to send copies to anyone interested in economic railway maintenance.

Asphalt Mastic Floors.—Under the above title the American Asphaltum & Rubber Co., of Chicago, Ill., has issued a handsomely illustrated catalog showing several installations of this waterproof, acid proof and sanitary flooring which, has been adopted by some of the largest business concerns in the country. This floor has safely passed from the experimental stage, as the first one was laid down some twelve years ago. Reports on floors which have been used for a much longer period than the guaranteed five years indicate that they are still in a good state of preservation.

Steam Engineering Specialties.—In its new catalog No. 10, issued by the Wm. Powell Co., Cincinnati, O., much time and thought has been expended to make it readily understood and comprehensive to the prospective buyer. With this end in view all the articles have been re-figured, and the intention is to retain these in all subsequent catalogs. The articles are consecutively numbered, and these numbers are placed at the top of each page beside the page numbers, thereby rendering it unnecessary to refer to the index to locate the figure numbers. The catalog is a substantially bound book of 287 pages and contains a supplement of valuable tables and useful information, compiled by the late James Powell. It is requested that all previous issues of the catalog be destroyed, and that orders be placed by figure numbers in this new "No. 10" catalog.

Nickel-Chrome Chilled Car Wheels.—The advantages of this wheel, as demonstrated by very complete service tests on the Pennsylvania Railroad, have been presented in a very interesting pamphlet just issued by the Nickel-Chrome Chilled Car Wheel Company, Frick Bldg., Pittsburgh, Pa. In the general description of the wheel and of the tests, the fact is emphasized that nothing has been added to the ordinarily employed mixture to increase its strength, the only advance made by car wheel manufacturers being in the employment of metallurgists to analyze the scrap car wheels and other mixtures now in use, in order to insure a more uniform mixture. The effect of nickel and chrome is to so modify the chilled surface of the tread as to toughen it, and give greater mileage, and the results of the various tests are conclusive in indicating the attainment of the desired end. The pamphlet will repay an attentive perusal.

Steel Mine Timbers.—The Carnegie Steel Co., of Pittsburg, Pa., has recently published a book of data and tables for mining engineers, and a well illustrated album showing the types of construction and examples of installation of steel mine timbers. The substitution of steel for wood for this purpose avoids all those elements of economic waste to which timber is liable, particularly waste in framing and fitting, waste from destruction by decay or insects, and more than all, waste by fire; to which may also be added that the use of steel within the mines means less excavation, better ventilation, less erection cost and greater endurance. These two books constitute valuable additions to existing literature on mine engineering. The first mentioned contains a number of working sketches showing the application of steel for gangway supports and mine props. Some 28 pages are devoted to the presentation of very complete data tables covering safe load in pounds for both steel and the various wooden timbers.

NOTES

Joseph Dixon Crucible Co.—Sherman Paris has succeeded H. S. Snyder in the advertising department of the above company.

National Boiler Washing Co.—Announcement is made by this company, of Chicago, Ill., of office removal in the Railway Exchange from No. 1707 to No. 529.

Under-Feed Stoker Co. of America.—This company announces the removal of its general offices to the Harris Trust Building, Monroe street, between Clark and La Salle, Chicago, Ill.

Chicago-Cleveland Car Roofing Co.—Announcement of the removal of offices has been made by this company, from 720 Old Colony Building, where it has been located for seventeen years, to 427-429 People's Gas Building, Chicago, Ill.

Burton W. Mudge & Co.—Announcement has been made that Thomas H. Garland has been elected as a director of the company. Mr. Garland is the inventor of the Garland Car Ventilator, which is manufactured and sold exclusively by Mudge & Company.

Homestead Valve Mfg. Co.—This company announces the appointment as its agents in Louisville and vicinity, the E. D. Morton Co., who will carry a stock of Homestead valves and will be ready at all times to supply the trade in that city and adjacent territory.

Transportation Utilities Co.—Reuben C. Hallett, well known throughout the railroad field, has been appointed to the sales-staff of the recently organized Transportation Utilities Company, direct representatives of the Acme and General Railway Supply Companies of Chicago, with headquarters at 30 Church street, New York City.

American Steel Foundries Co.—Warren J. Lynch, formerly passenger traffic manager of the New York Central lines west of Buffalo, has been elected to the fourth vice-presidency of the American Steel Foundries Company. Mr. Lynch will make his headquarters at the New York sales office of the company.

J. F. Faessler Mfg. Co.—This company, of Moberly, Mo., makers of Boss and Universal flue expanders, flue cutters and other boiler tools, has reorganized its sales department and placed Chas. F. Palmer in charge, as sales manager, with office at 810 Olive street, St. Louis. Mr. Palmer is well qualified for this position through previous experience in selling Faessler tools and as representative of the Frank E. Palmer Supply Co. of St. Louis.

Westinghouse, Church, Kerr & Co.—John I. Wallace, formerly Chief Engineer of the Panama Canal, who retired after inaugurating the American work on the canal and afterwards designed the new Chicago & Northwestern passenger terminal at Chicago, which has just been completed at a cost of $25,000,000, has assumed active charge as President of Westinghouse, Church, Kerr & Company, who were the engineers for the new Pennsylvania Railroad station in New York. Among the directors elected at the annual meeting of the company are N. W. Halsey and F. Q. Brown, of New York, George Westinghouse and J. R. McGinley, of Pittsburg, and Homer Loring, of Boston.

Railway Steel Spring Co.—The annual report of the Railway Steel-Spring Company, New York, for the year ending December 31, 1910, shows that gross sales were $10,035,435, an increase of $2,192,143 over 1909. The surplus, after fixed charges, was $810,077, or 6 per cent. on the $13,500,000 common stock, as compared with 5.32 per cent. earned on the same stock in 1909. At the annual meeting Otis H. Cutler, president of the American Brake Shoe & Foundry Company, Mahwah, N. J., was elected a director to succeed the late Frank S. Layng. The officers of the company and the other directors were re-elected.

Universal Vanadium Co.—Under the laws of the State of Delaware, the above company has recently been incorporated with the following officers and directors: Edward M. McIlvain, president, 30 Church street, New York, N. Y.; Col. Millard Hunsiker, vice-president, 23 Rue de la Paix, Paris, France; James C. Gray, secretary and treasurer, Frick Building, Pittsburgh, Pa.; Joseph W. De Wyckoff, European representative, 64 Victoria street, Westminster, London, England; E. Marshall Fox, Wetley Rocks, Staffordshire, England, and William McIlvain, Reading, Pa. The Universal Vanadium Company was formed for the purpose of acting as selling agents for the American Vanadium Company in a more comprehensive and effectual manner, and it will act in a selling capacity in conjunction with the Vanadium Sales Company.

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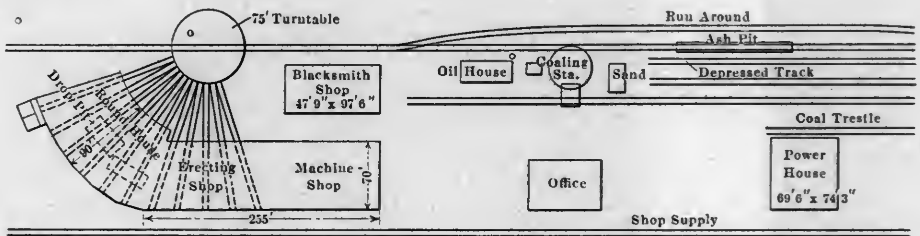

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30 in. American "patented head" lathe	10 "

CATALOGS

Freight, Baggage and Express Handling.—The Automatic Transportation Company, of Buffalo, N. Y., has published an illustrated pamphlet descriptive of its electric truck, which has been specially designed and constructed for handling package freight at railway and steamship terminals, and in fact all institutions which require trucking about the premises. The truck operated by storage batteries weighs 1,800 pounds and will carry from 2,000 to 4,000 pounds.

Gas Engines.—The Mesta horizontal double-acting four-cycle gas engine is described and illustrated in a new catalog issued by the Mesta Machine Company, of Pittsburg, Pa. This company does not build what are termed small gas engines, their smallest size being about 400 horsepower, but they turn out all sizes from that up to the largest engine used. The present catalog contains some well executed half-tones, suppelmentary to the descriptive matter, and concludes with a very interesting and instructive comparison between gas versus steam power.

Graphite Lubrication.—A booklet has just been issued by the International Graphite Company, of Niagara Falls, N. Y., which reproduces the very interesting and instructive address on the above subject which was delivered by Dr. Edward G. Acheson before the Automobile Club of America, May 17, 1910, and before the National Gas and Gasoline Engine Trades Association, Cincinnati, O., June 14, 1910. This little book is of great value to users of graphite and to those interested in the subject and it will well repay a careful perusal.

Silica-Graphite Paint.—The Josepn Dixon Crucible Company, of Jersey City, N. J., has just published a very neat folder entitled "Maintenance Painting for Electric Railways." It gives excellent photographs of street railway viaducts, power plant stacks, and car trucks painted with Dixon's silica-graphite paint. The folder explains in a very interesting way the special adaptability of this paint for street railway uses, and the Paint Department of that company will be glad to send copies to anyone interested in economic railway maintenance.

Asphalt Mastic Floors.—Under the above title the American Asphaltum & Rubber Co., of Chicago, Ill., has issued a handsomely illustrated catalog showing several installations of this waterproof, acid proof and sanitary flooring which, has been adopted by some of the largest business concerns in the country. This floor has safely passed from the experimental stage, as the first one was laid down some twelve years ago. Reports on floors which have been used for a much longer period than the guaranteed five years indicate that they are still in a good state of preservation.

Steam Engineering Specialties.—In its new catalog No. 10, issued by the Wm. Powell Co., Cincinnati, O., much time and thought has been expended to make it readily understood and comprehensive to the prospective buyer. With this end in view all the articles have been re-figured, and the intention is to retain these in all subsequent catalogs. The articles are consecutively numbered, and these numbers are placed at the top of each page beside the page numbers, thereby rendering it unnecessary to refer to the index to locate the figure numbers. The catalog is a substantially bound book of 287 pages and contains a supplement of valuable tables and useful information, compiled by the late James Powell. It is requested that all previous issues of the catalog be destroyed, and that orders be placed by figure numbers in this new "No. 10" catalog.

Nickel-Chrome Chilled Car Wheels.—The advantages of this wheel, as demonstrated by very complete service tests on the Pennsylvania Railroad, have been presented in a very interesting pamphlet just issued by the Nickel-Chrome Chilled Car Wheel Company, Frick Bldg., Pittsburgh, Pa. In the general description of the wheel and of the tests, the fact is emphasized that nothing has been added to the ordinarily employed mixture to increase its strength, the only advance made by car wheel manufacturers being in the employment of metallurgists to analyze the scrap car wheels and other mixtures now in use, in order to insure a more uniform mixture. The effect of nickel and chrome is to so modify the chilled surface of the tread as to toughen it, and give greater mileage, and the results of the various tests are conclusive in indicating the attainment of the desired end. The pamphlet will repay an attentive perusal.

Steel Mine Timbers.—The Carnegie Steel Co., of Pittsburg, Pa., has recently published a book of data and tables for mining engineers, and a well illustrated album showing the types of construction and examples of installation of steel mine timbers. The substitution of steel for wood for this purpose avoids all those elements of economic waste to which timber is liable, particularly waste in framing and fitting, waste from destruction by decay or insects, and more than all, waste by fire; to which may also be added that the use of steel within the mines means less excavation, better ventilation, less erection cost and greater endurance. These two books constitute valuable additions to existing literature on mine engineering. The first mentioned contains a number of working sketches showing the application of steel for gangway supports and mine props. Some 28 pages are devoted to the presentation of very complete data tables covering safe load in pounds for both steel and the various wooden timbers.

NOTES

Joseph Dixon Crucible Co.—Sherman Paris has succeeded H. S. Snyder in the advertising department of the above company.

National Boiler Washing Co.—Announcement is made by this company, of Chicago, Ill., of office removal in the Railway Exchange from No. 1707 to No. 529.

Under-Feed Stoker Co. of America.—This company announces the removal of its general offices to the Harris Trust Building, Monroe street, between Clark and La Salle, Chicago, Ill.

Chicago-Cleveland Car Roofing Co.—Announcement of the removal of offices has been made by this company, from 720 Old Colony Building, where it has been located for seventeen years, to 427-429 People's Gas Building, Chicago, Ill.

Burton W. Mudge & Co.—Announcement has been made that Thomas H. Garland has been elected as a director of the company. Mr. Garland is the inventor of the Garland Car Ventilator, which is manufactured and sold exclusively by Mudge & Company.

Homestead Valve Mfg. Co.—This company announces the appointment as its agents in Louisville and vicinity, the E. D. Morton Co., who will carry a stock of Homestead valves and will be ready at all times to supply the trade in that city and adjacent territory.

Transportation Utilities Co.—Reuben C. Hallett, well known throughout the railroad field, has been appointed to the sales-staff of the recently organized Transportation Utilities Company, direct representatives of the Acme and General Railway Supply Companies of Chicago, with headquarters at 30 Church street, New York City.

American Steel Foundries Co.—Warren J. Lynch, formerly passenger traffic manager of the New York Central lines west of Buffalo, has been elected to the fourth vice-presidency of the American Steel Foundries Company. Mr. Lynch will make his headquarters at the New York sales office of the company.

J. F. Faessler Mfg. Co.—This company, of Moberly, Mo., makers of Boss and Universal flue expanders, flue cutters and other boiler tools, has reorganized its sales department and placed Chas. F. Palmer in charge, as sales manager, with office at 810 Olive street, St. Louis. Mr. Palmer is well qualified for this position through previous experience in selling Faessler tools and as representative of the Frank E. Palmer Supply Co. of St. Louis.

Westinghouse, Church, Kerr & Co.—John I. Wallace, formerly Chief Engineer of the Panama Canal, who retired after inaugurating the American work on the canal and afterwards designed the new Chicago & Northwestern passenger terminal at Chicago, which has just been completed at a cost of $25,000,000, has assumed active charge as President of Westinghouse, Church, Kerr & Company, who were the engineers for the new Pennsylvania Railroad station in New York. Among the directors elected at the annual meeting of the company are N. W. Halsey and F. Q. Brown, of New York, George Westinghouse and J. R. McGinley, of Pittsburg, and Homer Loring, of Boston.

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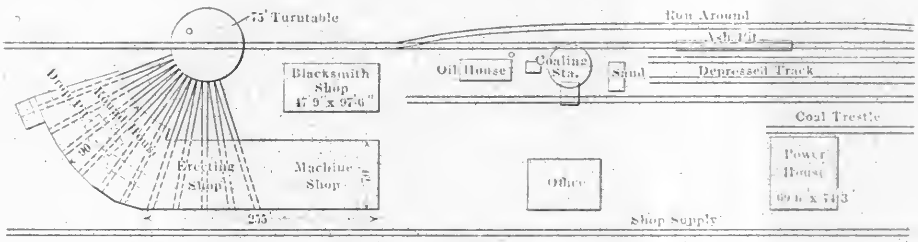

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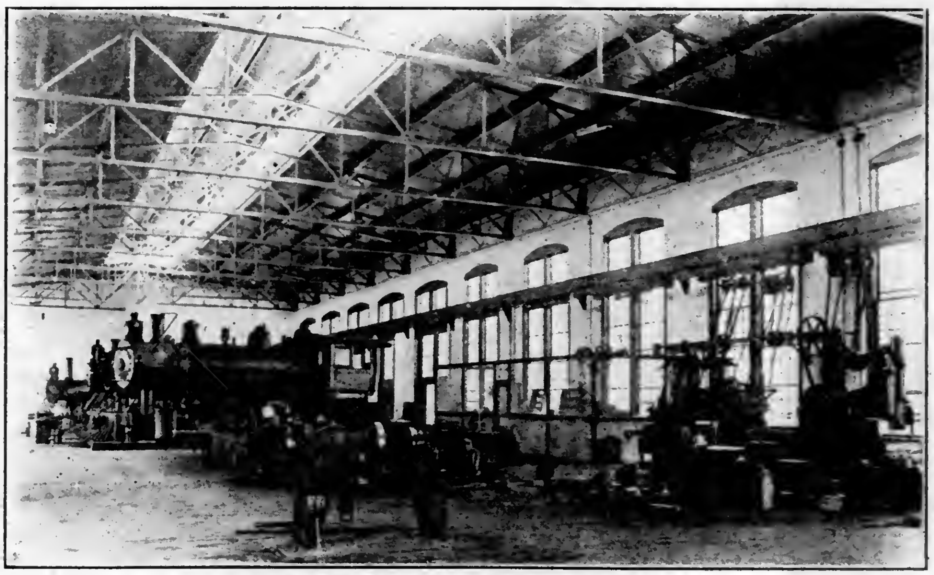


GENERAL VIEW OF THE ERECTING SHOP.

TOOLS.	MOTORS.
Niles planer	7½ h. p.
30 in. American "patented head" lathe	[illegible] "

TOOLS.	MOTOR.
Group	7½ h. p.
16 in. Blair lathe.	
18 in. American lathe.	
18 in. Lodge & Shipley lathe.	
Group	7½ "
18 in. Lodge & Shipley lathe.	
28 in. Lodge & Shipley lathe.	
36 in. Niles lathe.	
Williams pipe machine	3 "
Group	5 "
Acme double head bolt cutter.	
Williams bolt cutter.	
Emery wheel.	

TOOLS.	MOTOR.
Bickford radial drill	5 h. p.
Dill slotter	5 "
Group	7½ "
Niles slotter.	
Gould & Eberhardt shaper.	
Brown & Sharpe milling machine	5 "
Group	3 "
Reamer grinder.	
Drill grinder.	

In addition to the space occupied by the machine tools there is a liberal amount of floor area left for benches and the usual tinsmith, air brake and other bench work equipment is provided. Other tools required, as for instance a driving wheel lathe, boring mill, etc., will be added in the near future. One of the illustrations shows the arrangement of countershaft along the side wall, used in connection with the group drive. This gives a clear open head space for the crane and liberal length of belt without complication.

In the roundhouse there are good-sized benches between each of the pits, which have a vise and are arranged as lockers for other tools. The heating throughout this section and the other buildings is by direct radiation from steam pipes in the pits and along the side wall.

A 75 ft. turntable is contained in a concrete pit, floored with concrete, and is driven by a McGrath pneumatic turntable tractor manufactured by the Draper Mfg. Co., Port Huron, Mich.

The equipment for boiler and blacksmith shop work is contained in a brick building with a wooden roof truss and cinder floor, measuring 50 by 100 ft., located conveniently as is shown in the general layout. In this building is the following equipment: Flue cutting machine, furnace, welding machine, swedging machine, testing machine and annealing furnace. This group is driven by a 7½ h.p. motor. In the opposite corner is a flanging fire with its clamp, and a pair of hand bending rolls; nearby is a hand shear, a Hilles & Jones punch and shear driven by a 5 h.p. motor; a 1,100 lb. steam hammer; a 600 lb. steam hammer, both provided with jib cranes and each served by three open fires.

INTERIOR OF ROUNDHOUSE—CAPE CHARLES SHOPS.

A CORNER OF THE MACHINE SHOP, SHOWING ARRANGEMENT OF COUNTERSHAFT WITH GROUP DRIVE.

A large power house supplies light and power for the yards, depot and the offices scattered throughout the terminal. This has been housed in a most attractive building 70 x 75 ft. which contains three 200 h.p. boilers, hand fired, and two 175 k. v. a. three-phase, 60 cycle, 2,400 volt generators, each driven by a 14 x 18 in. slide valve engine. In the fire room there are two fire pumps, each having a capacity of 500 gallons per minute, also boiler feed pumps and general water service pumps in duplicate. A large feed water heater comprises a portion of the equipment. The water supply for the plant is obtained from 40 driven wells near the power house. In the engine room in addition to the generators there is a 20 k.w. motor generator set for exciting and a similar size turbo-generator set used for starting the alternators. The current leaves the power house at 2,400 volts and is transformed by static transformers before entering the various buildings where it is to be used, and it is delivered to the motors at a pressure of 220 volts. In the power house is also the air compressor which has a capacity of 690 cu. ft. of air per minute. Two 25-light mercury rectifier sets have been installed for the current which is to light the yard, the lamps there being for direct current. The switchboard and all equipment throughout the powerhouse is of the highest character and was carefully installed. Space is provided for additional equipment to increase the present capacity by 50 per cent.

A two-story and basement storehouse and office building of 50 x 72 ft. has been constructed. An electric elevator of 6,000 lbs. capacity has been installed in the store section. In this building, as well as in the offices of the various foremen, the light is by tungsten lamps instead of the Cooper-Hewitt mercury lamps generally used. The oil house is 22 x 53 ft. and contains the usual tanks and arrangement for storage and delivery of oil and waste. The ash pits are of the standard Pennsylvania type and coaling is done by a clam shell bucket on a stationary jib crane operated by a steam hoisting engine.

Ample provision for protection from fire is had by means of the 6 in. fire main, in the form of a loop surrounding the plant, supplying the various plugs throughout the yard and the hose reels in the interior of the various buildings. Two 50,000 gallon steel tanks provide the storage and the pressure for ordinary service. Toilet and wash rooms with hot and cold water and expanded metal lockers have been installed throughout the shop for the comfort and convenience of the employees.

RIGID VS. NON-RIGID FREIGHT TRUCKS

W. J. SCHLACKS.

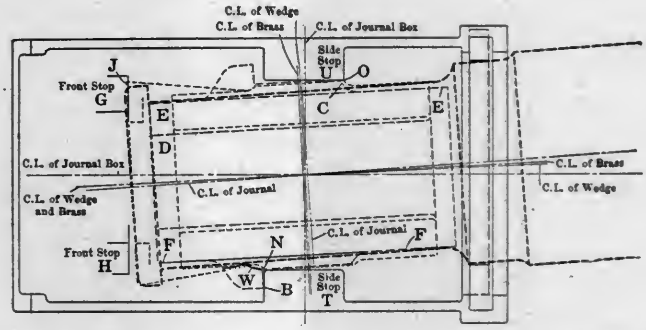
All the recent discussions on rigid vs. non-rigid freight trucks have not called attention as to whether discussions were based on the trucks being rigid or non-rigid in a vertical or a horizontal plane. A few years ago trucks, rigid in the horizontal plane as well as in the vertical plane, had considerable vogue, but there are not very many of them purchased at this time.

The rigid trucks in the horizontal plane were condemned because of the fact that it takes only three points to determine a plane, so that when the fourth wheel found a low spot in the track it was relieved of carrying its proportion of the load because the other three wheels determined the horizontal plane of the truck. We may assume, therefore, that all the recent discussion on rigid or non-rigid trucks is in the vertical plane; that is, whether a truck should be so constructed as to hold the axles perpendicular to the side frames.

The recent excellent report of Prof. Louis E. Endsley of Purdue University * shows that the total movement of some of the non-rigid trucks which ran out of square was as much as 5 61-100 in., half of which, 2 8-10 in., is the amount the truck ran out. Since then trucks have been found with a total movement of 6¼ in. of the side frames, or 3⅛ in. out of square.

To determine the position of the M. C. B. parts, such as brass, wedge and journal in the journal box, and in an effort to determine how much of a part was played by the journal box and contained parts in resisting the trucks running further out of square, the plan view of the journal box and contained parts, with the truck 5¼ in. out of square, is herewith reproduced.

It will be noted that there is not room enough in the M. C. B. journal box for the M. C. B. contained parts, with a truck so far out of square. The distance between the centers of the journals as measured on a line perpendicular to the side frame is reduced about ¼ in., due to the angularity of the axle. This causes the brass to take up the play allowed between the rear of the wedge and the flange on the brass, which forces the wedge towards the front stops. It will also be seen that the wedge laps over the front stop "G" at the point "J" about 1-32 in. The brass laps over the collar of the journal at the point



"D" about 1-16 in. by the side lug on the brass, binding the side stop "T" of the box at point "B." Both wedge and brass bind on the side stop "T" at "N" and "B," and on the side stop "U" at "C" and "O." The lines "EE" and "FF" of the brass are considerably out of parallel with the lines of the journal.

It has been determined from this that a truck would not run so far out of square without something in the journal box yielding, either by springing or breaking, and from the information gained through laying out the drawing as illustrated, it was concluded if these trucks really ran out of square excessively, and if the truck depended on the cramping of these parts to resist its running more out of square, the parts that were called upon to resist this excessive movement must indicate the trouble by excessive wear or breakage. The inspection of a number of these trucks in a high percentage of cars, showed brasses with the lugs broken off, as indicated by the line "W" in the drawing. Some of these trucks seemed to have no other means of holding them square except by the angularity of the journal, causing a binding of the brass and wedge between the side stops of the box, and the binding of the wedge on the front stop "G" of the box. This, if the brass or the wedge or the front stop of the wedge does not break, must cause excessive end wear of the journal collars and brass, and a diagonal wear of the brass or bearing on the journal, all of which must conduce towards increased liability of hot boxes and excessive frictional resistance.

From the number of brasses found with broken side lugs, it is fair to assume that a high proportion of these trucks depend on this resistance in limiting the distance they run out of square. It is interesting to note that on inspection of a large number of cars whose trucks were constructed in a manner that was meant to hold them square, that there was only one brass found with the side lug broken off, and that was on a truck, the spring plank of which was made of two angle irons securely riveted to arch bar columns, and in this truck one of the angle irons had broken, which made of it a flexible truck.

THE CHICAGO & NORTHWESTERN RAILWAY has an extensive spring making department in its smith shop at Chicago. New springs for all the locomotives on the system—1,700 engines—are made and old ones repaired at this plant.

* See AMERICAN ENGINEER, May, 1911, page 192.

TOOLS.	MOTOR.
Group	7½ h. p.
16 in. Blair lathe.	
18 in. American lathe.	
18 in. Lodge & Shipley lathe.	
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Williams pipe machine	3 "
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Acme double head bolt cutter.	
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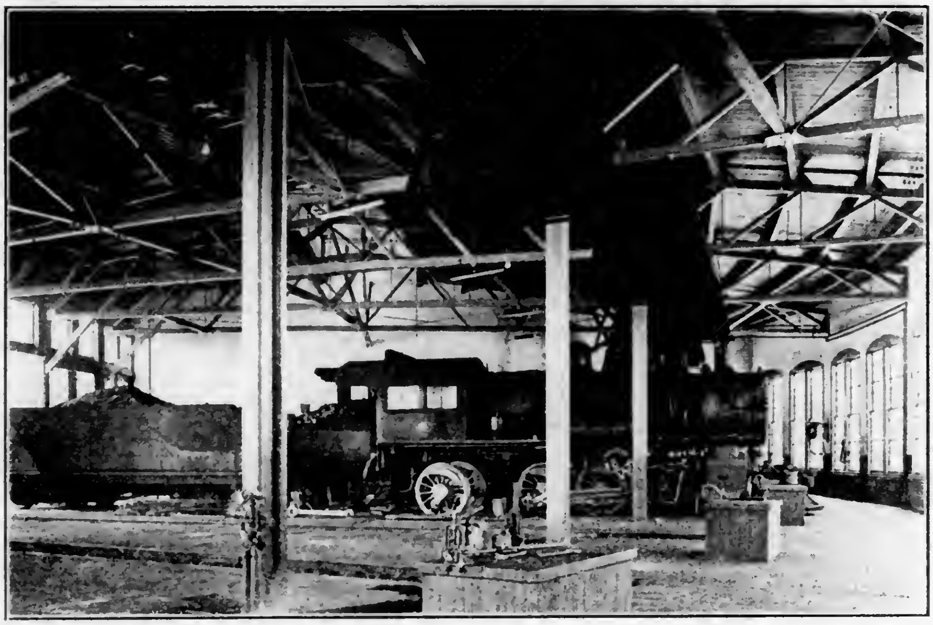
Emery wheel.	



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Dill slotter	5 "
Group	7½ "
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Gould & Eberhardt shaper.	
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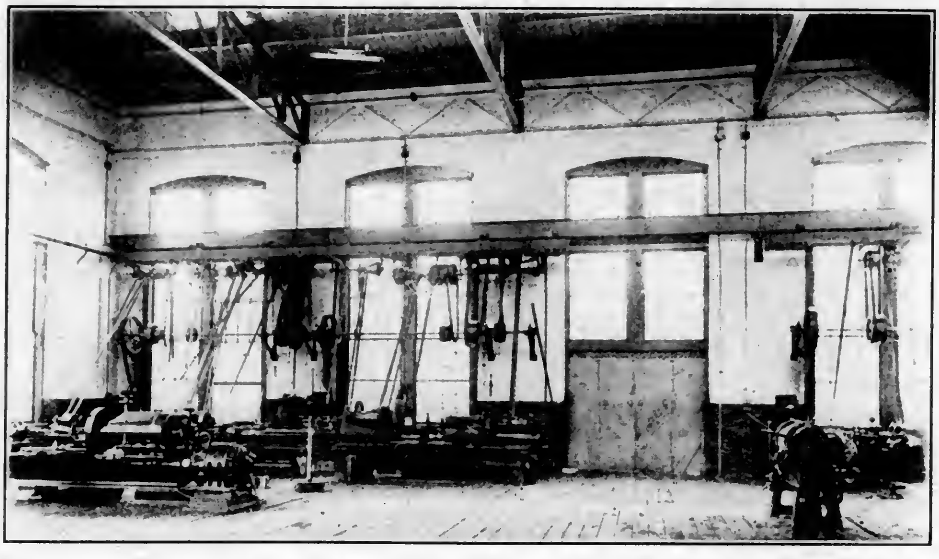

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A two-story and basement storehouse and office building of 50 x 72 ft. has been constructed. An electric elevator of 6,000 lbs. capacity has been installed in the store section. In this building, as well as in the offices of the various foremen, the light is by tungsten lamps instead of the Cooper-Hewitt mercury lamps generally used. The oil house is 22 x 53 ft. and contains the usual tanks and arrangement for storage and delivery of oil and waste. The ash pits are of the standard Pennsylvania type and coaling is done by a clam shell bucket on a stationary jib crane operated by a steam hoisting engine.

Ample provision for protection from fire is had by means of the 6 in. fire main, in the form of a loop surrounding the plant, supplying the various plugs throughout the yard and the hose reels in the interior of the various buildings. Two 50,000 gallon steel tanks provide the storage and the pressure for ordinary service. Toilet and wash rooms with hot and cold water and expanded metal lockers have been installed throughout the shop for the comfort and convenience of the employees.

RIGID VS. NON-RIGID FREIGHT TRUCKS

W. J. Schlacks.

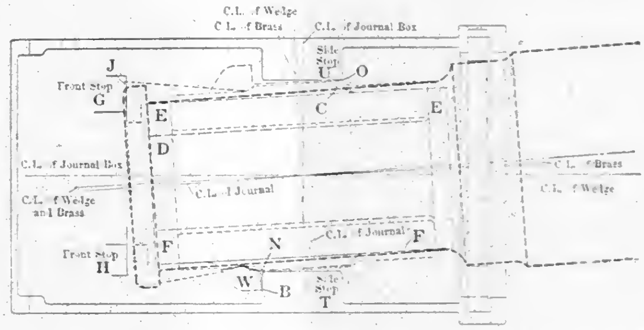
All the recent discussions on rigid vs. non-rigid freight trucks have not called attention as to whether discussions were based on the trucks being rigid or non-rigid in a vertical or a horizontal plane. A few years ago trucks, rigid in the horizontal plane as well as in the vertical plane, had considerable vogue, but there are not very many of them purchased at this time.

The rigid trucks in the horizontal plane were condemned because of the fact that it takes only three points to determine a plane, so that when the fourth wheel found a low spot in the track it was relieved of carrying its proportion of the load because the other three wheels determined the horizontal plane of the truck. We may assume, therefore, that all the recent discussion on rigid or non-rigid trucks is in the vertical plane; that is, whether a truck should be so constructed as to hold the axles perpendicular to the side frames.

The recent excellent report of Prof. Louis E. Endsley of Purdue University* shows that the total movement of some of the non-rigid trucks which ran out of square was as much as 5 61-100 in., half of which, 2 8-10 in., is the amount the truck ran out. Since then trucks have been found with a total movement of 6¼ in. of the side frames, or 3⅛ in. out of square.

To determine the position of the M. C. B. parts, such as brass, wedge and journal in the journal box, and in an effort to determine how much of a part was played by the journal box and contained parts in resisting the trucks running further out of square, the plan view of the journal box and contained parts, with the truck 5¼ in. out of square, is herewith reproduced.

It will be noted that there is not room enough in the M. C. B. journal box for the M. C. B. contained parts, with a truck so far out of square. The distance between the centers of the journals as measured on a line perpendicular to the side frame is reduced about ¼ in., due to the angularity of the axle. This causes the brass to take up the play allowed between the rear of the wedge and the flange on the brass, which forces the wedge towards the front stops. It will also be seen that the wedge laps over the front stop "G" at the point "J" about 1-32 in. The brass laps over the collar of the journal at the point



"D" about 1-16 in. by the side lug on the brass, binding the side stop "T" of the box at point "B." Both wedge and brass bind on the side stop "T" at "N" and "B," and on the side stop "U" at "C" and "O." The lines "EE" and "FF" of the brass are considerably out of parallel with the lines of the journal.

It has been determined from this that a truck would not run so far out of square without something in the journal box yielding, either by springing or breaking, and from the information gained through laying out the drawing as illustrated, it was concluded if these trucks really ran out of square excessively, and if the truck depended on the cramping of these parts to resist its running more out of square, the parts that were called upon to resist this excessive movement must indicate the trouble by excessive wear or breakage. The inspection of a number of these trucks in a high percentage of cars, showed brasses with the lugs broken off, as indicated by the line "W" in the drawing. Some of these trucks seemed to have no other means of holding them square except by the angularity of the journal, causing a binding of the brass and wedge between the side stops of the box, and the binding of the wedge on the front stop "G" of the box. This, if the brass or the wedge or the front stop of the wedge does not break, must cause excessive end wear of the journal collars and brass, and a diagonal wear of the brass or bearing on the journal, all of which must conduce towards increased liability of hot boxes and excessive frictional resistance.

From the number of brasses found with broken side lugs, it is fair to assume that a high proportion of these trucks depend on this resistance in limiting the distance they run out of square. It is interesting to note that on inspection of a large number of cars whose trucks were constructed in a manner that was meant to hold them square, that there was only one brass found with the side lug broken off, and that was on a truck, the spring plank of which was made of two angle irons securely riveted to arch bar columns, and in this truck one of the angle irons had broken, which made of it a flexible truck.

* See American Engineer, May, 1911, page 192.

The Chicago & Northwestern Railway has an extensive spring making department in its smith shop at Chicago. New springs for all the locomotives on the system—1,700 engines—are made and old ones repaired at this plant.

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The present engines are of interest in embodying some departures from the standards of the Associated lines. The first common standard Pacific type locomotive, built in 1903, had a straight boiler, 70 in. in diameter. In the new design the boiler has a wagon top, and measures 74 in. in diameter at the front end, and 85 in. at the dome ring. This engine has also the greatest length of flues, 22 ft., thus far applied by the builders to a 4-6-2 type locomotive. The tubes are spaced with 13/16 in. bridges. The smoke box is 94 inches long and contains an unusually large area of netting.

In further comparison with the first common standard Pacific type locomotive it is noticeable that while the steam pressure, driving wheel diameter and piston stroke remain as before, the cylinder diameter has been increased to 25 in., thus raising the tractive effort from 29,800 to 38,700 pounds. The boiler capacity is proportionally large, as 306 square feet of heating surface are provided for each cubic foot of cylinder volume.

The cylinders are in many respects similar to those used on the previous type, except that they are larger, and have the steam chest centers 4½ in. outside the cylinder centers, so that a satisfactory design of Walschaert gear can be applied. By-pass valves of the Sheedy type are used, in accordance with the regular practice of the Associated Lines for piston valve cylinders. The piston valves are of the built-up type, 15 in. in diameter. The valve rod crosshead guide is supported in front by the steam chest head, and at the rear by the guide yoke. The main guides can thus be adjusted to take up wear, without in any way disturbing the adjustment of the gear.

The connecting rods are of forged open hearth steel, the main rods having an I-section while the side rods are rectangular. The front side rods have a continuous taper in depth, from front to back, while the width remains constant. This arrangement facilitates the forging of the rod, at the point where the rod body joins the large middle connection stub. It also provides a section giving the necessary strength with more lateral flexibility than can be secured when an I-section is used. This enables the rod to better accommodate itself to the side play of the wheels in their boxes.

The frames and running gear require little special comment. The front lower rail is cast in one piece with the main frame, while the upper rail is separate, and is of forged iron. The Hodges type of trailing truck is used, and in this case it is fitted with helical centering springs. The tender has a rectangular water bottom tank of 9,000 gallons capacity, and is similar in design to the present common standard tender. The coal capacity has been increased from 10 to 15 tons. The tender truck wheels, as well as those of the engine truck, are of solid rolled steel, and were manufactured by the Standard Steel Works Co.

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GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Lignite
Tractive effort	38,700 lbs.
Weight in working order	265,400 lbs.
Weight on drivers	164,850 lbs.
Weight on leading truck	50,150 lbs.
Weight on trailing truck	50,400 lbs.
Weight of engine and tender in working order	435,000 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel base, total	35 ft. 8 in.
Wheel base, engine and tender	65 ft. 7½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.8
Tractive effort × diam. drivers ÷ heating surface	613.15
Total heating surface ÷ grate area	69.42
Firebox heating surface ÷ total heating surface, %	4.83
Weight on drivers ÷ total heating surface	33.91
Total weight ÷ total heating surface	54.60
Volume both cylinders, cu. ft.	16
Total heating surface ÷ vol. cylinders	306
Grate area ÷ vol. cylinders	4.37
CYLINDERS.	
Kind	Simple
Diameter and stroke	25 x 28
VALVES.	
Kind	Piston
Diameter	15 in.

* See AMERICAN ENGINEER, October, 1910, page 404.

WHEELS.	
Driving, diameter over tires	77 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Wagon top
Working pressure	200 lbs.
Outside diameter of first ring	74 in.
Firebox, length and width	120 x 84 in.
Firebox plates, thickness	F. ½, B. ⅜, S. ⅜ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	356—2¼ in.
Tubes, length	22 ft.
Heating surface, tubes	4,593 sq. ft.
Heating surface, firebox	235 sq. ft.
Heating surface, total	4,860* sq. ft.
Grate area	70 sq. ft.
TENDER.	
Tank	Water bottom
Frame	Steel channels
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,000 gals.
Coal capacity	15 tons

*Includes 32 sq. ft. for arch tubes.

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The present status of the manufacture of locomotive boiler tubes and a review of main points requiring attention in order that the best service may be attained under modern conditions, were admirably presented in a paper by F. N. Speller of the National Tube Company, read at the April 28 meeting of the Pittsburg Railway Club. After an interesting comparison between former universally used charcoal iron tube and the now fully developed tube of basic open hearth steel, low in carbon, and with less than 0.05 per cent. phosphorus and sulphur, it was pointed out that there is no difficulty in securing a strong weld with this steel. Attention was also called to the fact that seamless and lap welded steel tubes are now made from practically the same grade of soft basic open hearth steel. Mr. Speller then presented the following main points which invite consideration in following out the process:

1. Resistance to Corrosion.

The manufacturer should furnish a tube in the best possible condition to withstand corrosion and pitting; that is, the metal should be as uniform in composition and density as it is possible to make it. Much can be done to lessen the tendency to pitting by proper attention to the making of steel and the way it is worked. We have been experimenting on this problem now for several years and have gone to considerable trouble in the matter of testing and inspection of material, and in the process used for manipulating the steel so as to produce a tube which will resist corrosion as well as iron can be made to do so, and, judging from the reports of comparative service tests which have been received, steel so made is, in this respect at least, the equal of the best charcoal iron.

After all, however, the solution of this problem is largely in the hands of the user. Iron or steel will corrode in spite of anything that can be done if certain material is in solution in the water, particularly dissolved oxygen or carbonic acid. By the removal of these harmful agencies corrosion may be reduced to practically nothing. It is generally understood nowadays that water conditions have everything to do with corrosion, and the simplest solution of the problem is to treat the water, with the object of making it as harmless as possible. The development of the modern tube to withstand corrosion and the treatment of water have together practically eliminated this trouble, so that it is rarely the case that tubes fail nowadays through pitting.

2. Leaking in the Flue Sheet.

The construction and handling of the engine has so much to do with the trouble experienced from leaky flues that it is difficult to determine how much, if any, of the responsibility for this should be placed on the tube material. If railroad engineers will tell us what qualities are required in the tube to make it hold tight in the flue sheet, we will be glad to follow their suggestions as closely as possible. At the present time the steel tube is made as stiff as possible consistent with the best welding quality and ability to stand up successfully under expansion and beading in the tube sheet.

3. Strength and Ductility of Material.

The tube should be of such quality as to stand repeated tightening in the flue sheet without cracking or showing undue evidence of fatigue, nor should these weaknesses develop during the life of the flue in service. The material found best adapted to give these properties is a special grade of soft open hearth steel carrying not over 0.05 per cent. phosphorus or sulphur.

4. Weldability and Heat Treatment.

The quality of the metal and method of handling are equally important in safe ending. Soft steel has been found somewhat harder to weld than charcoal iron, but it has been greatly improved in this respect. The necessity for a good welding quality steel is of first consideration in making locomotive tubes so that they may be easily safe ended, and this point has received a great deal of study, especially in the manufacture of lap-welded tubes, where it is, of course, one of the first essentials to manufacture. Charcoal iron carries considerably more impurities than soft open hearth steel, and these impurities form a self-fluxing mixture which facilitates welding. Railroad specifications have been so tightly drawn on composition in some cases as to work against the production of a good quality of steel for locomotive boiler tubes by calling for unnecessarily low phosphorus and sulphur. There is now very good reason to think that a mistake has been made in this direction, and that the general welding quality of the steel would be much improved, and the steel at the same time would lose nothing in other respects, if the maximum phosphorus and sulphur limits were both raised to 0.05 per cent. With producer gas, now generally used of necessity, it is a very difficult matter to keep the average sulphur in the heat below 0.035 per cent., and in order to remove this sulphur in the open hearth furnace the steel has to be held and worked in such a way as frequently to leave it dry and difficult to weld.

Before the steel can be welded in practice a fluid cinder must be formed on the surfaces which are to be united. If the metal is heated too far above the point at which this cinder should flow, it will be burned and destroyed. We endeavor to have the range of temperature between the cinder forming and burning points in the steel as wide as possible so as to assist in lap welding and give the largest margin of safety in safe ending. Considering the variety of the requirements it seems to us that the compositions of the metal should be left largely to the discretion of the manufacturer so far as is consistent with a certain specified standard of physical quality in the finished tube. We frequently go to the trouble of rephosphorizing for the purpose of improving the fluxing and welding quality of our steel.

The method of safe ending, we have said, has as much to do with obtaining satisfactory results as the material, but we will

FLANGE, CRUSHING AND FLATTENING TESTS.

not attempt to lay down specific rules as to construction of the furnace and heating, for many of the practical shop men present who are welding flues every day are much more able to discuss this side of the problem. However, there are a few broad principles on the heat treatment of tube steel which should be taken into consideration. The preliminary heating of the body tube preparatory to flaring out the end should be carried to a bright orange color judging by good shop light, 1,750 degrees F. In the case of steel on steel, if the body tube is allowed to cool black after heating to this temperature and inserting the safe end, the grain structure will be refined and the metal put in much better condition for the welding operation which follows. Moreover, if the preheated body tube is returned to the furnace without cooling the metal may be crystallized or burned before the safe end has been heated hot

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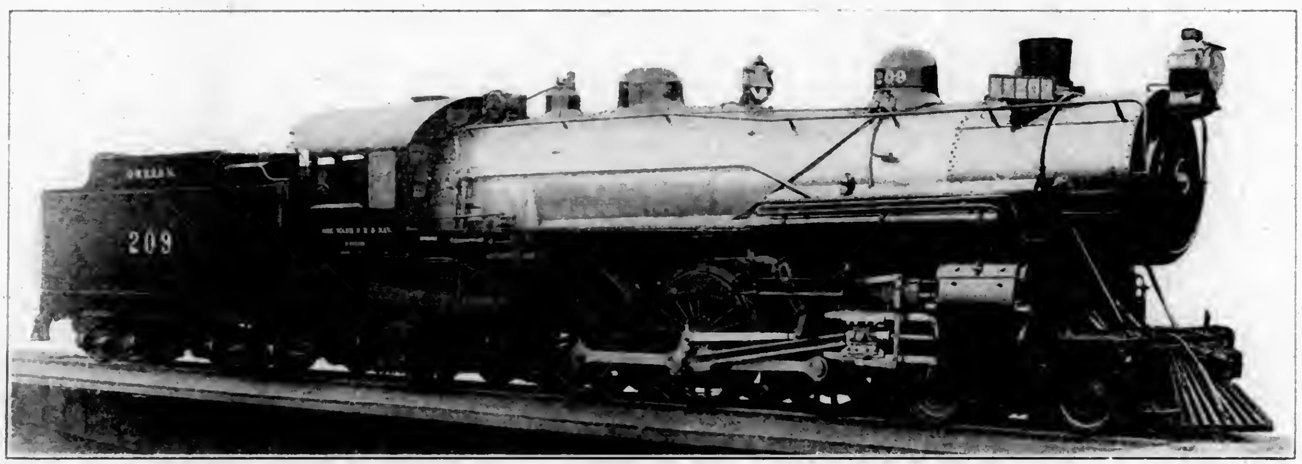

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Wheel base, engine and tender	65 ft. 7½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.[illegible]
Tractive effort × diam. drivers ÷ heating surface	613.15
Total heating surface ÷ grate area	69.42
Firebox heating surface ÷ total heating surface, %	4.83
Weight on drivers ÷ total heating surface	33.91
Total weight ÷ total heating surface	54.60
Volume both cylinders, cu. ft.	16
Total heating surface ÷ vol. cylinders	306
Grate area ÷ vol. cylinders	4.37

CYLINDERS.

Kind	Simple
Diameter and stroke	25 x 28

VALVES.

Kind	Piston
Diameter	15 in.

* See AMERICAN ENGINEER, October, 1910, page 401.

WHEELS.	
Driving, diameter over tires	77 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
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Before the steel can be welded in practice a fluid cinder must be formed on the surfaces which are to be united. If the metal is heated too far above the point at which this cinder should flow, it will be burned and destroyed. We endeavor to have the range of temperature between the cinder forming and burning points in the steel as wide as possible so as to assist in lap welding and give the largest margin of safety in safe ending. Considering the variety of the requirements it seems to us that the compositions of the metal should be left largely to the discretion of the manufacturer so far as is consistent with a certain specified standard of physical quality in the finished tube. We frequently go to the trouble of rephosphorizing for the purpose of improving the fluxing and welding quality of our steel.

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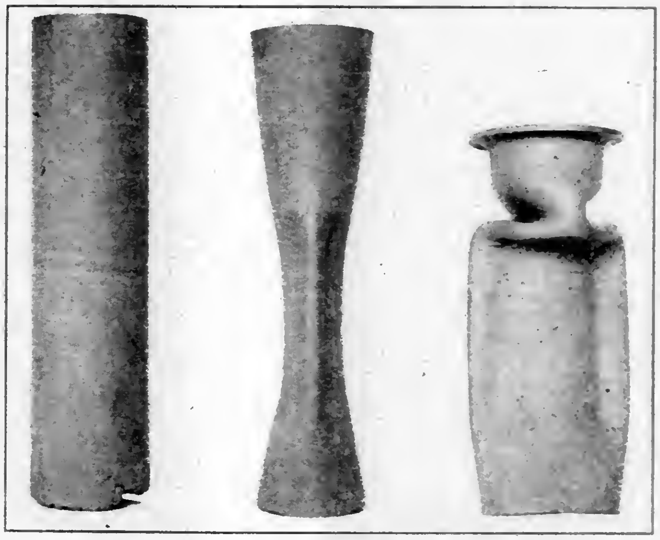

FLANGE, CRUSHING AND FLATTENING TESTS.

not attempt to lay down specific rules as to construction of the furnace and heating, for many of the practical shop men present who are welding flues every day are much more able to discuss this side of the problem. However, there are a few broad principles on the heat treatment of tube steel which should be taken into consideration. The preliminary heating of the body tube preparatory to flaring out the end should be carried to a bright orange color judging by good shop light, 1,750 degrees F. In the case of steel on steel, if the body tube is allowed to cool black after heating to this temperature and inserting the safe end, the grain structure will be refined and the metal put in much better condition for the welding operation which follows. Moreover, if the preheated body tube is returned to the furnace without cooling the metal may be crystallized or burned before the safe end has been heated hot

enough to weld. Should there be any considerable difference in thickness between the safe end and body tube, it is evident that there is again a risk of overheating the one before the other is sufficiently heated to weld. If the body tube is returned to the furnace while red hot and the safe end is at the same time a gauge or two heavier, there is, of course, all the more chance of crystallizing or burning the body tube at or near the weld. Taking unnecessary risks of this kind often explains subsequent failures which should not be charged up to the flue maker.

It is not unusual for a flue welder who has never handled steel to have trouble for a few days. Remembering the above points and using his experience to the best advantage as to the condition of his furnace, the character of the flame, temperature, etc., the average man will soon be able to do equally reliable work with steel as with charcoal iron, as the experience of welders all over the country will show.

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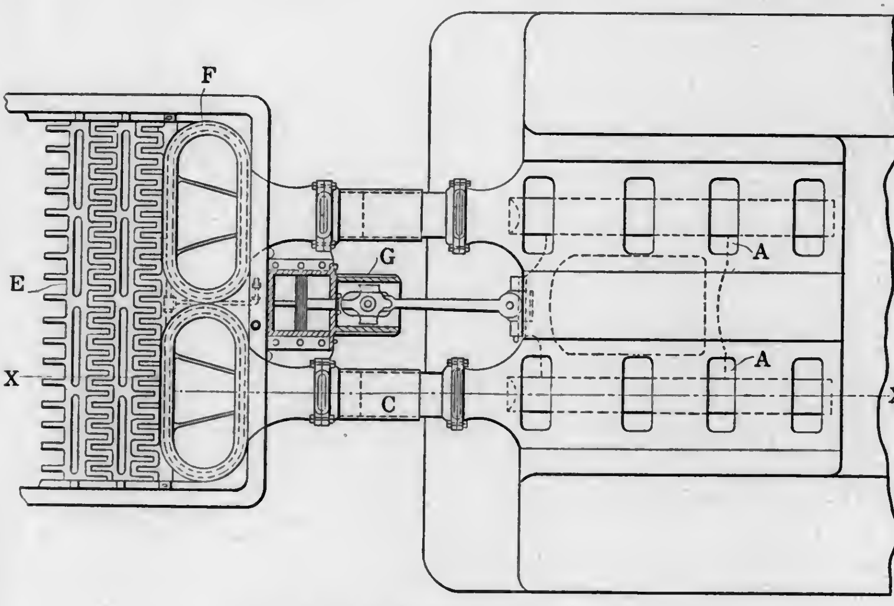
The charging mechanism may be readily understood through reference to the accompanying plan and sectional drawings. It will be noted that the coal falls through a series of rectangular openings into the path of the reciprocating plunger. The series of depressions and forwardly pointing teeth in the latter form a conveyor adapted to gradually advance the fuel received at any point in the hopper chamber until it drops down in front of the plunger, and is forced through the flexible conveying tubes (C).

The forward end of these tubes opens into a tubular chamber, continuous with the coking chamber (D). This chamber lies below the level of the fire grate, and slopes upward to the rear end of the grate, forming an underfeed chamber in which the fuel is gradually brought to the temperature of the fire grate, and in which the light gases of the fuel are driven off, allowing them to be consumed by the incandescent material lying above the fire grate.

The distribution of the fuel over the grate is effected by a blower (F) connected to the rim of the coking chamber (D) and immediately above the level of the grate at that point. It consists of a blowing ring, surrounding the opening of the coking chamber and having a number of openings, directed upward and forward, to which blasts of steam are supplied for the purpose of blowing the partially coked fuel forward on the grate, and to aid in the combustion of the mass of fuel in the chamber (D). This ring is supplied by exhaust steam from the engine (G) which operates the charging mechanism.



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In adopting the device to locomotives with unusually wide fireboxes the general arrangement as herein indicated is preserved on the tender, but in the firebox the coking ducts (D)

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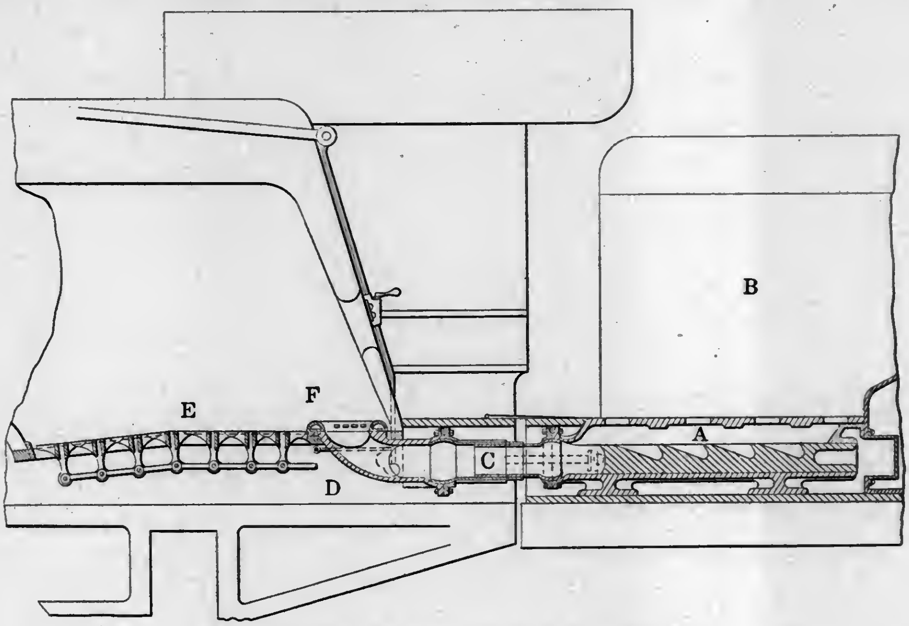

SECTIONAL VIEW, SHOWING CHARGING MECHANISM.

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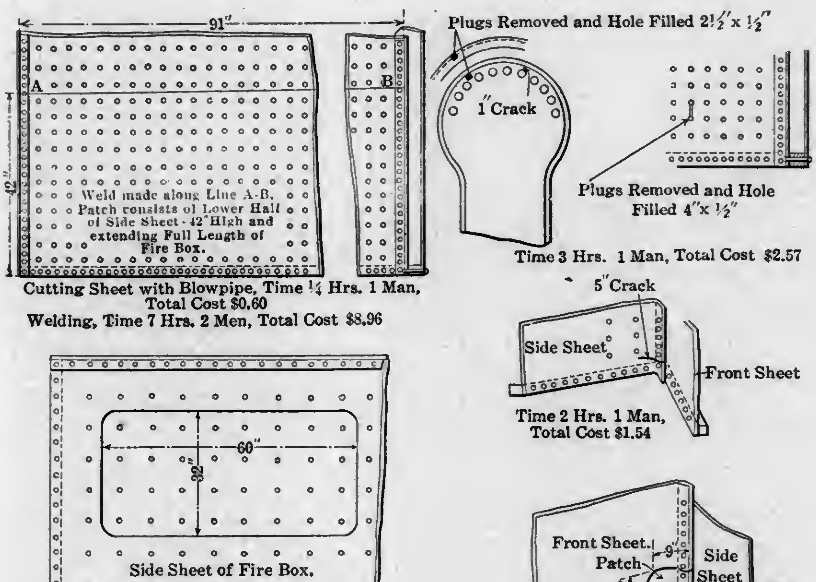

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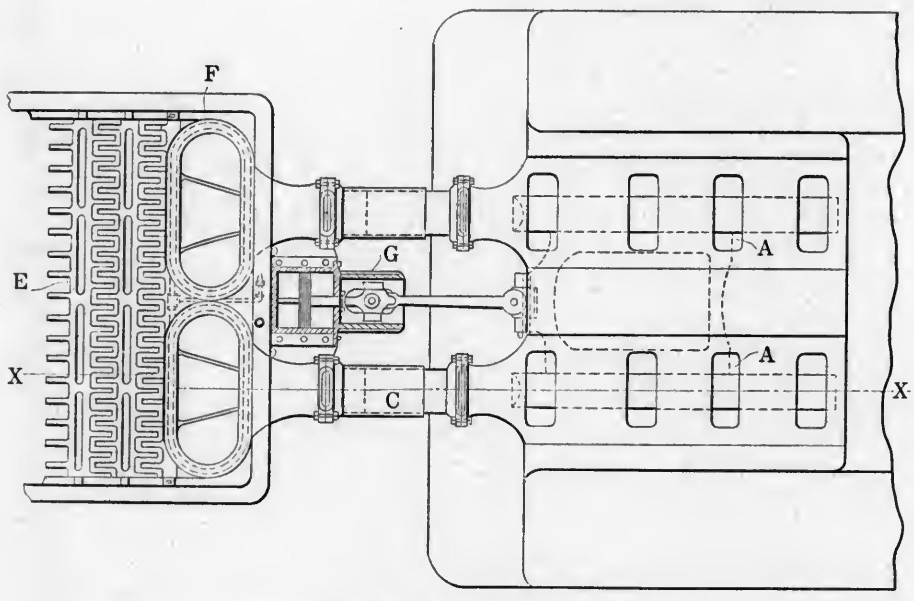

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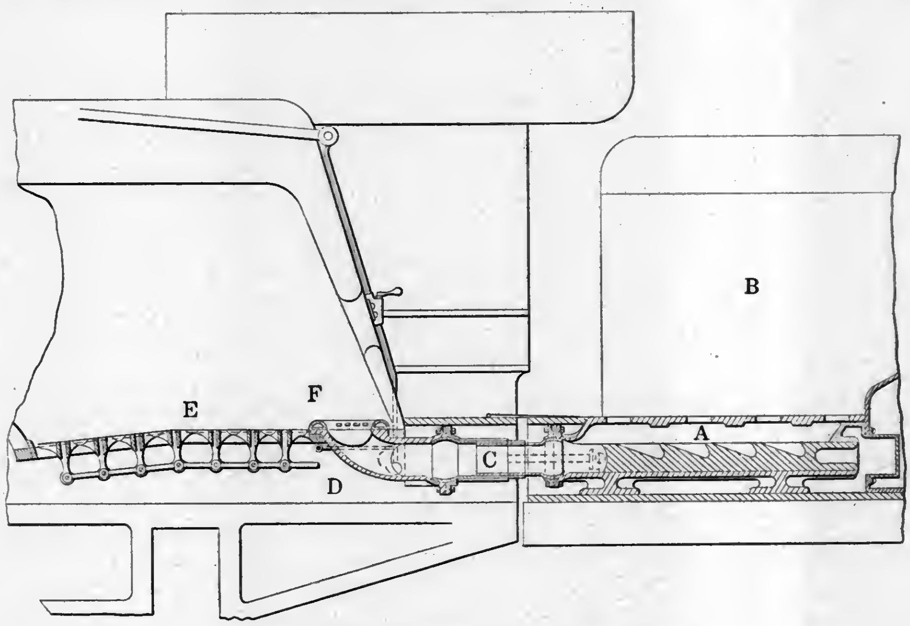

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A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

MALLET ARTICULATED COMPOUND LOCOMOTIVES

TYPE	2-10-10-2	2-8-8-2†	0-8-8-0	0-8-8-0	2-8-8-2	2-8-8-2	2-8-8-2	2-8-8-2	0-8-8-0	2-6-6-2	2-8-8-2	2-6-8-0	4-4-6-2†	0-8-8-0	2-6-6-2	2-6-6-2	0-6-6-0	0-6-6-0
Name of Road	A. T. & S. F.	A. T. & S. F.	B. & O.	D. & H.	V. R. R.	N. P.	S. P.	S. L. & S. F.	Erie	C. & O.	N. & W.	G. N.	A. T. & S. F.	N. & W.	C. B. & Q.	B. & A.	D. N. W. & P.	Can. Pac.
Road number or class	3,000	1,700	2,401	1,600	600	4,000	4,000	2,001	2,600	H. 1	Y-1	1,959	1,300	X-1	4,100	1,249	200	1900
Builder	R. R. Co.	Bald.	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Amer.	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.	Can. Pac.
When built	1911	1909	1911	1910	1910	1910	1909	1910	1907	1910	1910	1909	1909	1910	1909	1910	1909	1909
Tractive effort, lbs	111,600	108,300	105,000	105,000	100,800	94,640	94,640	83,300	94,800	82,000	77,000	82,000	62,850	85,000	70,500	66,600	74,130	57,400
Weight, total, lbs	616,000	462,450	461,000	445,000	448,750	437,950	425,900	425,000	410 000	392,000	390,000	378,300	376,850	376,800	361,650	342,000	327,500	262,000
Weight on drivers, lbs	550 000	412,350	461,000	445,000	405,400	403,800	394,150	365,000	410,000	324,000	360,000	359 600	268,400	376,800	304,500	296,500	327,500	262,000
Weight on leading truck, lbs	....	24,050	....	....	21,000	18,750	14,500	25 500	....	22,000	15 000	18,700	58,050	....	21,000	....	....	....
Weight on trailer, lbs	....	26,050	....	....	22,350	15,400	17,250	34,500	....	46,000	15,000	....	50,400	....	36,150	....	....	....
Weight, tender loaded, lbs	234,000	234,000	181,500	1 66,800	171,130	152,000	170,100	162,420	167,700	164,300	170,000	147,700	234,000	161,860	153,400	152,700	159,800	139,000
Wheel base, driving, front group	19' 9"	16' 6"	15'	14' 9"	15'	16' 0"	15' 0"	15' 6"	14' 3"	10'	15' 6"	10'	6' 4"	15' 6'	11' 6"	10'	10'	10' 4"
Wheel base, driving, rear group	19' 9"	16' 6"	15'	14' 9"	15'	16' 0"	15' 0"	15' 6"	14' 3"	10'	15' 6"	15'	12' 8"	15' 6'	11' 6"	10'	10'	10' 4"
Wheel base, total engine	66' 5"	59' 10"	40' 8"	40' 2"	58' 2"	56' 7"	56' 7"	56' 8"	39' 2"	48' 10"	55' 6"	43' 11"	51' 11"	41' 2"	51' 5"	30' 8¼"	30' 8"	35' 2"
Wheel base, engine and tender	108' 1⅝"	98' 0⅞"	77' 2¼"	75' 7½"	89' 2⅛"	82' 7¾"	83' 6"	85' 6¼"	70' 5½"	80' 3¼"	83' 3"	76' 2½"	94' 5½"	72' 10"	83' 2½"	74' 8"	64' 4"	60' 7'
Diameter of drivers	57"	63"	56"	51"	56"	57"	57"	57"	51"	56"	56"	55"	73"	56"	64"	57"	55"	58"
Cylinders, high pressure, diameter	28"	26"	26"	26"	26"	26"	26"	24"½	25"	22"	24½"	23"	24"	24½"	23"	20½"	20½"	23½"
Cylinders, low pressure, diameter	38"	38"	41"	41"	40"	40"	40"	39"	39"	35"	39"	35"	38"	39"	35"	33"	33"	34"
Cylinders, stroke	32"	34"	32"	28"	32"	30"	30"	30"	28"	32"	30"	32"	28"	30"	32"	32"	32"	26"
Steam pressure, lbs	225	220	210	220	210	200	200	200	215	225	200	200	220	200	200	210	225	200
Boiler, type	E. W. T.	Str.	Conical	Conical	Str.	Str.	Str.	Conical	Str.	Conical	Str.	Belp.	Str.	Str.	Str.	Str.	Str.	W. T.
Boiler, smallest diameter	79"	84"	90"	90"	86"	84"	84"	81⅝"	84"	83⅞"	80"	84"	72"	83⅞"	78"	83¾"	84"	57⅜"
Boiler, height center	....	....	10' 1"	120"	10' 3"	....	120"	10'	120"	10'	....	....	118"	10'	114½"	119½"	120"	110⅝"
Heating surface, tubes, sq. ft	3,625	4.766	5,205.5	6,276	4,934	4,941	4,941	4,817	4.971	5,646	4,309	3,038	3,275	5,188	2,708	5,291	5,035	2,605
Heating surface, firebox, sq. ft	294.5	243	321.4	353	250	252	232	350	343	344	210	225	202	200	210	185	206	180
Heating surface, feed heater, sq. ft	2,659.5	1.665	....	....	....	1,220	....	....	....	....	1 389	1,797	1,279	....	2,172	....	....	....
Heating surface, superheater, sq. ft	2,328.4	544	1 002	....	....		655	....	....	....	....	480	323	....	464	....	....	420
Heating surface, reheater, sq. ft	....	1,201	....	....	1,694	655	....	....	....	....	586	....	798	....	....	....	....	....
Heating surface, total,* sq. ft	6,579	6.674	5,526.9	6,629	5,184	6,413	5,173	5,167	5,314	6,013	5,908	5,060	4,756	5,388	5,090	5 476	5,241	2,785
Grate area, sq. ft	81.9	70.8	99.9	100	84	84	68.4	75.4	100	72.2	75.2	78	52.5	75	63	56.5	72.2	58
Firebox, length	149⅝"	129⅝"	123 3/16"	126⅛"	126' 1/16"	126"	126"	120⅛"	126⅛"	108⅛"	120⅛"	117"	119⅝"	120⅛"	120"	108"	108"	120"
Firebox, width	78¾"	78⅞"	114"	114"	96"	96"	78¼"	90¼"	114¼"	96⅛"	19¼"	96"	63¼"	90¼"	78¼"	75¼"	96"	69⅞"
Fuel, kind	Oil	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil.	Bit. coal	Lignite	Bit. coal	Bit. coal	Bit. coal
Tubes, number	377	387	277	446	401	401	401	342	404	401	350	275	294	367	218	410	409	**
Tubes, diameter	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	**
Tubes, length	16' 5"	21'	24'	24'	21'	21'	21'	24'	21'	24"	21'	15'	19'	24'	16' 6"	22'	21'	**
Tender, fuel capacity, tons	4,000	4000	16	14	15	13	2,850	16	16	15	14	13	4,000	14	13	12	12	12
Tender, water capacity, gallons	12,000	12,000	9,500	9,000	9,500	8,000	9,000	8,000	8,500	9,000	9,000	8,000	12,000	9,000	8,000	8,000	9,000	6,000
Weight on drivers ÷ tractive effort	4.93	3.78	4.42	4.23	4.16	4.26	4.18	4.32	4.32	3.96	4.67	4 38	4.27	4.42	4.33	4.45	4.40	4.57
Weight, total ÷ tractive effort	5.52	4.24	4.42	4.23	4.60	4.63	4.51	5.01	4.32	4.78	5.06	4.60	5.99	4.42	5.13	5.13	4.40	4.50
T. E. × diam. drivers ÷ total H. S.	967.00	1022.00	837.00	807.00	785.00	840.00	1040.00	919.65	910.00	763.00	730.00	894.00	965.00	887.00	886.00	693.00	780.00	1190.00
Total heating surface ÷ grate area	80.33	94.50	55.00	66.29	82.50	76.60	75.60	68.45	53.14	83.40	78.50	65.00	90.50	71.00	80.80	97.00	72.60	48.00
Firebox H. S. ÷ total H. S., %	4.47	3.65	5.80	5.31	4.82	3 90	4.50	6.11	6.46	6.10	3.55	4.45	4.25	3.95	4.13	3.40	3	6.46
Weight on drivers ÷ total heating surface	83.60	62.00	83.20	67.00	58.40	62.50	76.00	69.93	76.90	54.00	61.00	71.00	56.30	69.70	59.80	54.00	62.20	94.00
Weight, total ÷ total heating surface	93.63	69.40	83.20	67.00	64.70	68.00	82.50	80.97	76.90	65.30	66.00	75.00	79.20	69.70	71.00	62.00	62.20	94.00
Total H. S. ÷ superheating H. S.	2.39	12.40	5.25	....	....	....	7.90	....	....	....	....	10.50	14.70	....	10.97	....	....	6.63
Equivalent simple cylinder volume, cu. ft.	30.20	33.10	29.70	26.00	29.30	28.84	28.84	25.50	24.00	21.80	23.05	24.10	20.60	25.50	24.10	19.32	19 4	16.90
Total H. S. ÷ cylinder volume	217.85	205.00	237.00	254.00	236.00	223.00	180.00	202.42	222.00	276.00	256.00	210.00	232.00	210.00	212.00	283.00	270.00	165.00
Superheating H. S. ÷ cylinder volume		16.40	....	....	....	....	22.70	....	....	....	....	19.90	15.74	....	19.30	....	....	24.80
Grate area ÷ cylinder volume	2.71	2.14	3.36	3.85	2.87	2.91	2.38	2.95	4.70	3.31	3.26	3.24	2.54	2.96	2.64	2.92	3.70	3.44
Reference in The American Engineer, year, month and page	1911 May 171	1909 Dec. 477	1911 May 182	1910 June 207	1910 Nov. 427	1910 June 225	1909 May 181	1911 Feb. 50	1907 Sept. 338	1910 Dec. 471	1910 July 269	1910 Aug. 308	1909 Dec. 475	1910 Sept, 341	1910 May 171	1910 April 135	1909 Fe . 61	1910 March 81

* Includes boiler heating surface and feed water heating surface.
† Equipped with Jacobs superheater and feed heater.

** For number and size of tubes see American Engineer, p. 89, March, 1910.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED IN ORDER OF TOTAL WEIGHTS

FREIGHT AND SWITCHING LOCOMOTIVES

TYPE	CONSOLIDATION (2-8-0)									12-Wh'l 4-8-0	MIKADO 2-8-2					SWITCHING 0-10-0	0-8-0	0-6-0
NAME OF ROAD	N. Y. S. & W.	D. & H.	P. R. R.	W. P. T.	H. V.	L. S. & M. S.	C. & N. W.	C. G. W.	A. T. & S. F.	N. & W.	B. & O.	O. R. & N.	N. P.	C. M. & St. P.	V. R. R.	L. S. & M. S.	V. R. R.	P. & L. E.
Road number or class	140	1,011	H. 8 B.	918	C 10	5,962	1,455	503	1,950	M. 2	Q. 1	440	1,608	5,202	421	M.	2	253
Builder	Bald.	Amer.	P. R. R.	Amer.	Amer.	Amer.	Amer.	Bald.	Bald.	Bald.	Bald.	Bald.	Amer.	R. R. Co.	Baldwin	Amer.	Amer.	Amer.
When built	190n	1906	1909	1909	1910	1906	1910	1909	1908	1910	1911	1910	1906	1909	1909	1905	1909	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple
Tractive effort, lbs.	54,100	49,690	42,661	46 900	48,500	45,677	47,500	46,630	44,000	52,457	50,200	45.300	46,630	46,630	50,350	55,300	45,200	44,100
Weight, total, lbs.	260,100	246.500	238,300	236,000	236,000	232,500	232.000	222,650	212,400	262,000	274,600	263,100	261,000	260,500	254,000	270,000	182,300	178 200
Weight on drivers, lbs.	232,700	217,500	211,000	207,000	208,000	207.000	205,000	198,850	183,200	221,780	219.000	204,450	205,000	201,000	207,450	270,000	182 300	178,200
Weight on leading truck, lbs.	27,400	29,000	27,300	29.000	28,000	25,500		23,800	29.200	40 220	19,500	24,100	26,000	25,500	20.850			
Weight on trailer, lbs.											36.100	34,550	30,00	34,500	25,700			
Weight, tender loaded, lbs.	161,900	152,400	158,000	154,000	154 000	149.600	150,900	144.000	175,200	146,700	161,500	161,900	177,800	154,000	173,000		111,400	121,300
Wheel base, driving	17′ 0″	17′ 0″	17′ 0½″	15′ 9″	17′ 3″	17′ 6″	17′ 6″	17′	15′ 6″	16′	16′ 9″	16′	16′ 6″	16′ 6″	15′ 6″	19′ 0″	14′	12′ 0″
Wheel base, engine	26′ 6″	25′ 11″	25′ 9½″	25′	26′ 5′	26′ 5″	26′ 5″	25′ 8″	24′ 6″	27′ 1″	35′	34′ 8″	34′ 9″	35′ 1″	33′	19′ 0″	14′	12′ 0″
Wheel base, engine and tender	60′10″	57′ 7½″	59′ 5⅝″	59′ 11″	58′ 3″	60′ 9½″	60′ 9½″	58′ 6″	58′ 5″	61′ 11½″	71′ 1 9/16″	64′ 7″	63′ 1″	65′ 7¼″	65′ 10¼″	54′ 5½″	49′ 6 11/16″	46′ 2¼″
Diameter of drivers	63″	57″	62″	58″	57″	63″	61″	63″	57″	56″	64″	57″	63″	63″	56″	52″	51″	60″
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter and stroke	28″ × 32″	23″ × 30″	24″ × 28″	25″×32″	23″ × 30″	23″ × 32″	25′ × 32″	24″ × 30″	24″ × 32″	24″ × 30″	24″ × 32″	23¾″×30″	24″ × 30″	24″ × 30″	24″ × 32″	24″ × 28″	22″ × 28″	21″ × 30″
Valve gear, type	Wals	Wals.	Wals.	Wals.	Baker	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Steph.	Steph.
Steam pressure, lbs.	160	210	205	160	205	200	170	200	160	200	205	180	200	200	180	210	200	200
Boiler, type	Str.	Wooten	Belp.	E. W. T.	E. W. T.	Str.	Str.	Str.	Str.	W. T.	E. W. T.	Str.	E. W. T.	E. W. T.	Str.	W. T.	Str.	Str.
Boiler, smallest diameter	84″	83¾″	76¾″	80″	80″	81⅝″	81½″	80″	78¾″	80″	78″	82″	75¾″	75¾″	78¾″	80 1/16″	74″	80″
Boiler, height center	120″	113″	117″		9′ 9″	118¼″	120½″		114″	9′ 11¼″	9′ 8″	9′ 7½″	118″	118″	112″	115″	109″	108½″
Heating surface, tubes, sq. ft.	3,931	3,716	3,652	3,093	3,328	3492.18	3 499	3.514	2,773	4,281	4,789	5,292	3,192	3,332	4,277	4,422.6	2,763	2,906
Heating surface, firebox, sq. ft.	198	329.5	187	190	202	213.05	214	171	157	179	.228	267	245†	282†	189	197	177	206
Heating surface, total, sq. ft.	4.129	4045.5	3,839	3,283	3,503	3705.23	3,713	3,685	2,930	4,460	5.017	5,559	3,437	3,614	4,466	4,619.6	2,940	3,112
Heating surface, superheater, sq. ft.	834			374					600									
Grate area, sq. ft.	60.2	99.85	55.13	50.5	55	56.5	52.7	49.5	47.4	45	70	70	43.5	48.8	51	55.4	31.5	33.3
Firebox, length	120″	126⅛″	110¼″	109″	108⅛″	108⅛″	108⅛″	108″	95⅛″	100⅛″	120″	120″	96″	107″	102″	108⅛″	108″	120″
Firebox, width	72¼″	114″	72″	68″	73¼″	75¼″	70¼″	66″	71¼″	64¼″	84″	84″	65¼″	65¾″	72″	73¼″	42″	40
Fuel, kind	Bit. coal	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Liquite	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	472	493	465	358	412	446	443	413	355	386	389	495	372	366	374	447	564	430
Tubes, number superheater				20														
Tubes, diameter, firetube	2″	2″	2″	2″	2″	2″	2″	2″	2″	2¼″	2¼″	2″	2″	2″	2¼″	2″	2″	2″
Tubes, diameter, superheater				5¼″														
Tubes, length	16′	14′ 6″	15′	14′ 6″	15′ 6″	15′	15′ 2″	16′ 4″	14′ 11″	18′ 10″	21′	20′ 6″	16′ 6″	17′ 6″	19′ 6″	19′ 0″	15′	13′ 0″
Tender, coal capacity, tons	15	14	17.50	14	16	12	12	12.50	3,300 G	14	16	10	12	14	16	12	10	10
Tender, water capacity, gals.	9,000	7,800	7,000	8,000	7,500	7,500	7,500	8,000	8,500	9.000	9,500	9,000	10,000	8,000	9,500	8.000	5,000	7,000
Weight on drivers ÷ tractive effort	4.30	4.30	4.95	4.41	4.29	4.50	4.30	4.28	4.17	4 08	4.37	4.50	4.38	4 31	4.10	4 86	4.03	4.04
Weight, total ÷ tractive effort	4 80	4.97	5.59	5.03	4.87	5 00	4.88	4.77	4.75	4.99	5.47	5 80	5 60	5.80	5.05	4.86	4.03	4 04
T. E. × diam. drivers ÷ total H. S.	825.00	700.00	689.00	825.00	783.[illegible]4	775.00	780.00	796.00	855.00	714.00	641.00	465.00	855.00	812.80	631.00	625.00	785.00	710.00
Total heat. surf. ÷ superheater heat. surf.	68.50	40.50	69.64	65.00	64.18	65.80	70.40	74.30	62.00	91.80	71.80	79.30	78.80	74.00	87.50	83.00	93.20	94.00
Firebox heat. surf. ÷ total H. S., %	4.80	8.12	4.87	5.80	5.72	5 75	5.00	4.65	5.35	4.43	4.56	4.80	7.12	7.80	4.23	4.25	6 04	6.60
Weight on drivers ÷ total heating surface	56.00	53.50	54.96	63 00	58.92	55 80	53.90	54 00	62 50	51.80	43.80	36.70	59.60	55.62	46.50	58.30	62.00	57.10
Weight, total ÷ total heating surface	53.00	60.80	62.07	71.70	66.86	6.25	62.30	60.40	72.50	63 50	54 80	47.30	75.50	72.21	56.90	58.30	62.00	57.10
Total heat. surf. ÷ superheating heat. surf.	5.00			8.78					4.90									
Cylinder volume, cu. ft.	22.70	14.40	14.66	18.20	14.42	15.40	18.16	15.60	16.80	15.80	16.80	16.00	15.80	15.70	16.75	14.70	12.35	12.00
Total heating surface ÷ cylinder volume	181.00	280.00	261.89	181.00	244.80	242.00	204.00	236.20	174.50	260.00	300.00	360.00	218.00	230.19	266.00	314.00	239.00	260.00
Superheater heat. surf. ÷ cyl. volume	36.80			20.60					35.50									
Grate area ÷ cylinder volume	2.65	6.92	3.76	2.78	3.81	3.66	2.90	3.18	2.82	2 83	4.17	4.53	2.76	3 10	3.05	3.78	2 55	2 77
Reference in THE AMERICAN ENGINEER, year, month, page	1907 Aug. 300	1907 Jan. 22	1910 Feb. 69	1909 June 256	1910 Dec. 478	1906 July 262	1910 July 259	1910 Feb. 64	1908 Mar. 112	1911 Jan 6	1911 April. 143	1910 Oct. 404	1906 Oct. 392	1909 Aug. 305	1909 June 225	1905 Sept. 330	1909 Sept. 357	1906 Sept. 346

† Includes combustion chamber.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF THE PACIFIC (4-6-2) AND PRAIRIE (2-6-2) TYPES

TYPE.	PACIFIC (4-6-2)														PRAIRIE (2-6-2)			
Name of road	P. R. R.	N. Y. C.	B. & O.	Vandalia	C. & N.W.	C. M. & St. P.	C. & A.	C. N. & W.	C. & A.	G. N.	C. B. & Q.	A. T. & S. F.	N. Y. N. H. & H.	C. B. & Q.	A. T. & S. F.	C. B. & Q.	N. P.	G. N.
Road number or class	K 28	3426	2140	V K 1	E	F 4	623	1,500	605	1,445	2,850	1290	11	S1	1800	R5	2,378	J1
Builder	Amer.	Ame .	Bald.	Amer.	Amer.	C. M. & St. P.	Amer.	Amer.	Bald.	Bald.	Bald.	Bald.	Both		Bald.	Amer.	Amer.	Bald.
When built	1907	1911	1911	1910	1910	1910	1909	1910	1908	1909	1909	1908	1907	1906	1906	1906	1906	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Comp.	Simple	Simple	Simple
Tractive effort, lbs.	30,700	30,900	43,400	31,800	33,700	36,500	31,475	31,900	34,000	35,300	31,100	32,600	31,560	31,100	37,800	35,060	33,300	37,560
Weight, total, lbs.	272,500	269,000	263,800	256,000	250,000	248,800	248,000	245,000	243,200	235,750	234,900	232,750	229,500	228,000	248,200	216,000	209,500	209,000
Weight on drivers, lbs.	183,900	171,500	166,200	162,000	154,500	160,110	149,500	151,000	146,500	152,000	160,150	140,400	142,500	150,000	174,700	152,000	152,000	151,000
Weight on leading truck, lbs.		50,000	52,400	49,500	51,000	46,000			47,600	39,900	37,400	54,950	46,500	42,000	31,300	25,600		21,000
Weight on trailer, lbs.		47,500	45,200	44,000	45,000	42,700			49,100	43,850	37,350	37,400	41,000	36,000	42,200	38,400		37,000
Weight, tender loaded, lbs.	143,800	153,200	176,200	145,950	166,200	154,590	165,120	154,000	161,800	146,200	155,100	165,200	134,000	148,200	175,000	148,200	139,500	151,000
Wheel base, driving	13' 10"	14'	13'	13' 10"	13' 6"	14'	13' 9"	13' 6"	13' 9"	13'	12' 10"	1.' 8"	13' 1"	12' 10"	13' 8"	13' 4½"	11' 0"	13' 0"
Wheel base, engine	35' 2½"	36' 6"	34' 8"	34' 8½	34' 7"	35' 7"	34' 8½"	34' 7"	32' 8"	33' 9"	32' 9"	34' 4¾"	33' 5½"	32' 9"	33' 9"	30' 8½"	28' 11"	30' 9"
Wheel base, engine and tender	67' ¾"	67' 11"	70' 10⅝"	66' 6"	66' 10½"	67' 1¾"	66' 4"	66' 10½"	65' 8½"	66' 7½"	64' 3¼"	65' 2"	61' 2"	64' 3¼"	65' 0"	62' 2¼"	57' 3½"	63' 8"
Diameter of drivers	80"	79"	74"	80"	75"	69"	80"	75"	73"	73"	74"	73"	73"	74"	69"	69"	63"	69"
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2
Cylinders, diameter	24"	23½"	24"	24"	25"	23"	23"	23"	23"	26"	22"	25"	22"	22"	17½" & 29"	22"	21"	22"
Cylinders, stroke	26"	26	32"	26"	28"	28"	28"	28"	28"	30"	28"	28"	28"	28"	28"	28"	28"	30"
Valve gear, type	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Pill id	Wals.	Wals.	Wals.	Wal.			Steph.	Wals.	Steph.	Steph.	Wals.
Steam pressure, lbs.	205	200	205	200	170	200	200	190	200	150	200	160	200	200	225	210	200	210
Boiler, type	Str.	Conical	E. W. T.	Str.	E. W. T.	E. W. T.	E. W. T.	E. W. T.	W. T.	Belp.	W. T.	Str.	Str.	W. T.	E. W. T.	W. T.	E. W. T.	Belp.
Boiler, smallest diameter	78"	72"	78"	76½"	70 5/16"	72"	72"	70 5/16"	72"	72"	70"	72"	70"	70"	76"	70"	72⅛"	72"
Boiler, height center	119"	9' 9"	9' 11"	9' 9"	9' 8"	9' 4"		116"	113"	111"	109⅞"	114¼"	110"	109¾"	115"	107⅜"	115"	108"
Heating surface, tubes, sq. ft.	4243	3,192.9	4,789	4,193.6	30.92	3,651	3,869.	4.130.	3,721.	2,920.	3,610	3,202	3,743.	3,732.	3,803.	3,375.	2,105.	3,277.
Heating surface, firebox, sq. ft.	205	231.2	228	197.4	209	259	202.	236.	206.	213.	194	190	204.4	200.	217.	200.	235.	210.
Heating surface, total, sq. ft.	4,448	3,424 1	5,017	4,391	3,328	3,910	4,071.	4,366.	3,927.	3,133.	3,804	3,392	3,947.4	3,932.	4,020.	3,575.	2,340.	3,487.
Heating surface, superheater, sq. ft.		765			691					620.								
Grate area, sq. ft.	61.86	56.5	70	56½	53	48	49.5	53	33	54.15	55	49 05	53.5	54	53.8	54.	43.5	53.15
Firebox, length	111"	108⅛"	120"	108⅛"	108⅛"	107 1/16"	108"	108⅛"	120⅛"	126¼"	108⅛"	107⅞"	108⅛"	108⅛"	107 1/16"	108⅛"	96"	116"
Firebox, width	80¼"	75¼"	84"	75¼"	70¼"	65¾"	66"	70¼"	40¼"	66¼"	72¼"	66"	71¼"	72¼"	71¼"	72¼"	65¼"	66"
Fuel, kind	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	343	175	389	383	214	369	373	396	357	160	293	273	310	303	342	303	306	301
Tubes, number superheater		32			30					32								
Tubes, diameter, firetube	2¼"	2¼"	2¼"	2"	2"	2"	2"	2"	2"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2"	2¼"
Tubes, diameter, superheater		5½"			5½"					5½"								
Tubes, length	21'	21' 6"	21'	20' 11"	20'	19'	20'	20'	20'	21'	21'	20'	20' 6"	21' 0"	18' 10 9/16"	19' 0"	13' 3"	18' 6"
Tender, coal capacity, tons	11	12	16	12	15	10½	14	13	12½	13	13	33,009	14	13	14	13	12	13
Tender, water capacity, gals.	7,000	7,500	9,500	7.500	8,275	8,500	8,500	7,500	8,250	8,000	8,200	8.500	6,000	8,000	9,000	8,000	7,000	8,000
Weight on drivers ÷ tractive effort	6.00	5.55	3.83	5 10	4.09	4.39	4.74	4.73	4.26	4.31	5.17	4 33	4.50	4.80	4.60	4.30	4.60	4.00
Weight, total ÷ tractive effort	8.85	8.71	6.08	8.05	6.64	6.82	7 90	7.68	7.05	6.68	7.55	7.12	7.25	7.30	6.60	6.20	6.30	5.60
T. E. × diam. drivers ÷ total H. S.	550.00	534.00	641.00	580.00	846.90	641.56	618.00	548.00	640.00	822.00	605.00	700 00	585.00	585.00	650.00	677.00	900.00	746.00
Total heating surface ÷ grate area	72.00	81.00	71.80	77.50	63.15	80.12	82.30	82.40	119.00	57.65	69 20	68.50	73.50	71.30	74.00	64.80	53.80	65.00
Firebox heat. surf. ÷ total H. S., %	4.62	5.07	4 56	4.43	6.28	4.58	4 98	4.79	5.24	6.80	5.10	5 60	5.20	4.85	5.40	5.34	10.10	6.00
Weight on drivers ÷ total heat. surf.	41.50	37.50	33.10	37.00	46.12	40.95	36.60	34.80	37.30	48.51	42.40	41 50	36.20	38.00	43.50	42.50	65.00	43.50
Weight total ÷ total heating surface	61.20	59.00	52.60	58.50	75 27	63.42	61.00	56.20	62.00	75.24	61.30	68.50	58.20	58.00	62 00	60.70	89.50	60.00
Total H. S. ÷ superheater heat. surf.		4.47			4.81					5.05								
Cylinder volume, cu. ft.	13.60	13.10	16 80	13.60	15.90	13.46	13 50	13.28	13.00	18.50	12.30	16.00	12.30	12.30	12.1*	12.30	11.20	13.20
Total heating surface ÷ cyl. volume	326.00	348.00	300.00	322 00	209.30	290.49	302.00	328.00	290.00	169.34	310.00	212.00	321.00	38.00	334.00	290.00	209.00	265.00
Superheater heat. surf. ÷ cyl. vol.		58.38			43.45					3.40								
Grate area ÷ cylinder volume	4.55	4.32	4.17	4.15	3 30	3.62	3.67	3.99	2.44	2.92	4,48	3.10	4.20	4.39	4.43	4.46	3.89	4.03
Reference in THE AMERICAN ENGINEER, year, month, page	1907 July 267	1911 Apr. 133	1911 Apr. 143	1910 Oct. 391	1911 Feb 56	1910 Nov. 449	1909 July 268	1910 July 259	1908 Oct. 399	1909 Oct. 413	1909 Sept. 376	1908 Mar. 112	1907 Nov. 429	1906 Aug. 300	1906 Nov. 434	1906 Aug. 300	1906 Oct. 392	1906 Sept. 364

* Equivalent simple cylinders.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF TYPES OTHER THAN THE PACIFIC AND PRAIRIE

TYPE	ATLANTIC (4-4-2)								TEN WHEEL (4-6-0)							AMERICAN (4-4-0)		TANK (4-6-4)
Name of road	A. T. & S. F.	P. R. R.	U. P.	C. M. & St. P.	N. Y. N. H. & H.	N. P.	Har. Lines	C. R. I. & P.	B. & A.	S. P.	D. L. & W.	C. G. W.	N. Y. C.	N. C. & St. L.	C. & N W	C. R. R. of N. J.	D. L. & W.	C P.
Road number or class	1.480	E 6	21	951	F1	603	A-81	1,019	1,916	2,317	1,012	500	2,099	284	1393	852	955	T. 2 a
Builder	Bald.	P. R. R.	Bald.	Bald.	Amer.	Bald.	Bald.	Amer.	Amer.	Bald.	Amer.	Bald.	Amer.	Bald.	Amer.	Amer.	Amer.	C. P.
When built	1910	1910	1906	1907	1907	1909	1905	1905	1908	1907	1905	1909	1905	1908	1907	1905	1905	1910
Simple or compound	Comp.	Simple	Comp.	Comp.	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple.	Simple	Bal.comp	Simple	Simple	Simple	Simple
Tractive effort, lbs	23,600	25,797	24,281	22,000	24.670	24,760	23.560	24,700	31,000	36,570	35,100	33,060	31.000	29,200	30,900	23.120	23,710	28,000
Weight, total, lbs	231,675	231,500	209,000	204,119	200,000	197,050	196,000	191,300	208,000	203,300	201,000	198,050	194,500	181,400	179,500	161,300	151,200	236 000
Weight on drivers, lbs	112,125	133,300	110,000	105.966	105,500	100,800	105,000	107,100	158,000	160,000	154,000	144,950	148,000	134,000	135,500	111,300	100,000	135,000
Weight on leading truck, lbs	62,225	51,300	53.000	52 353	48,000	51,950	45,000	42,400			47,000	53,100	46,500	47,400	44,000	50,000	51.200	49,340
Weight on trailer, lbs	57,325	46,900	46,000	45 800	46,500	44,300	46,000	40,800	155,800	43,300								51,660
Weight, tender loaded, lbs	185,325	158,000	162,200	130 000	134,000	122,950	162,200	144,000		141,366	120,000	144,000	143,500	118,000	139,500	122,200	110,000	
Wheel base, driving	6′ 10″	7′ 5″	7′ 0″	7′ 6″	7′ 3″	6′ 10″	7′ 0″	7′ 0″	15′ 10″	13′ 10″	14′ 4″	15′ 3″	15′ 10″	12′ 0″	14′ 10″	8′ 3″	8′ 6″	14′ 10″
Wheel base, engine	32′ 8″	29′ 7½″	27′ 10″	32′ 2″	28′ 2″	27′ 10″	27′ 7″	27′ 5½″	26′ 10½″	25′ 10″	25′ 6″	27′ 1″	26′ 10½″	26′ 0″	25′ 10″	23′ 1½″	24′ 5″	38′ 10″
Wheel base, engine and tender	64′ 6 5/16″	60′ 2 9/16″	58′ 5″	66′ 9″	56′ 1″	57′ 3″	58′ 2″	57′ 2″	59′ 3″	58′ ¼″	54′ ¼″	57′ 9½″	59′ 2″	55′ 2″	57′ 9″	49′ 2″	51′ ⅝″	
Diameter or drivers	73″	80″	81″	85″	79″	73″	81″	73″	69″	63″	69″	73″	69″	66″	63″	69″	69″	63″
Cylinders, number	4	2″	4	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2″
Cylinders, diameter	15″ & 25″	22″	16″ & 27″	15″ & 25″	21″	21″	20″	21″	22″	22″	21½″	26″	22″	16″ & 27″	21″	19″	20″	20″
Cylinders, stroke	26″	26″	28″	28″	26″	26″	28″	26″	26″	28″	26″	28″	26″	26″	26″	26″	26″	26″
Valve gear, type	Wals.	Wals.	Wals.	Steph.	Wals.	Wals.	Steph.	Steph.			Steph.	Wals.	Steph.	Wals.	Wals.	Steph.	Steph.	Wals.
Steam pressure, lbs	220	205	200	220	200	185	200	185	200	200	215	150	200	210	200	200	185	200
Boiler, type	W. T.	Belp.	Str.	W. T.	E. W. T.	Str.	Str.	Str.	E. W. T.	W. T.	Str.	Str.	W. T.	W. T.	E. W. T.	W. T.	Str.	W. T.
Boiler, smallest diameter	72″	78½″	70″	66″	68″	72⅛″	70″	72″	72⅛″	72″	74⅝″	70″	70⅝″	64″	66⅛	62¼″	61 3/16″	62¼″
Boiler, height center	9′ 8⅞″	9′ 10″	113″	114″	110″		113″	108″	115	102″	116½″		115″	107″		113″		8′ 9⅜″
Heating surface, tubes, sq. ft	2 318	3 364	2475.	3008.	3041.	2112.	2475.	2227.6	3104.5	2788.	3156.3	2,206	3124.7	2550	2808.4	1838.1	1947.9	1,644
Heating surface, firebox, sq. ft	208	218	180.	168.	204.4	173.	174.	161.8	203.3	206.	221.7	149	202.7	185	150.8	167.6	190.8	155
Heating surface, total, sq. ft	2,526	3,582	2655.	3,194.	3245.4	2285.	2649.	2389.4	3307.8	2994.	3378.	2,355	3326.7	2735	2959.2	2005.7	2138.7	1,799
Heating surface, superheater, sq. ft	1,147*					480.		338.				460						365
Grate area, sq. ft	48	55.13	49.5	45″	53.5	43.5	49.5	44.8	54.9	32.1	94.8	49.5	54.93	34.8	46.27	81.6	87.54	33
Firebox, length	109⅝″	110¼″	108″	107″	108⅛″	96″	108″	96″	105⅛″	124″	126⅛″	108″	108⅛″	120″	102⅛″	122⅛″	126 3/16″	114″
Firebox, width	63¼″	72″	66″	60¼″	71¼″	65¼″	66″	67¼″	75¼″	37¼″	108¼″	66⅛″	75¼″	41⅞″	65¼″	96¼″	100″	41⅞″
Fuel, kind	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil.	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Anth. coal	Anth. coal	Bit. coal
Tubes, number firetube	273	460	297	268	347	196	297	173	400	355	398	203	400	256	337	280	280	173
Tubes, number superheater						22		54				24						22
Tubes, diameter, firetube	2¼	2″	2″	2¼″	2″	2	2″	2″	2″	2″	2″	2″	2″	2¼″	2″	2″	2″	2″
Tubes, diameter, superheater						5⅛″		3½″				5″						5″
Tubes, length	14′ 6″	13′ 11⅝″	16′ 0″	19′	16′ 10″	16′	16′ 0″	16′ 0″	14′ 11″	15″	15′ 3″	16′	14′ 11″	17″	16′ 0″	12′ 6″	13′ 4¼″	13′ 9⅜″
Tender, coal capacity, tons	3,300G	13	10	10	14	9	10	12	12	2,940G	10	12½	12	10.5	10	12	10	4½
Tender, water capacity, gals	9,000	7,000	9,000	7,000	6,000	6,000	9,000	7,000	8,000	7,000	6,000	8,000	7,000	5,500	7,500	5,000	5,000	3,000
Weight on drivers ÷ tractive effort	4.72	5.18	4.53	4 75	4.27	4.05	4.48	4.20	5.10	4.37	4.38	4.38	4.77	4.58	4.38	4 80	4.22	4.80
Weight total ÷ tractive effort	9.71	8.97	8.60	9.20	8.10	7.95	8.35	7.90	6.70	5.57	5.72	5.99	6.27	6.27	5 80	6.95	6.40	8,40
T. E. × diam. drivers ÷ total H. S.	692.70	578.00	740.00	610.00	600.00	790.00	717.00	754.00	647.00	770.00	717.00	1024.00	647.00	705.00	655.00	800.00	765.00	753.00
Total heat. surf. ÷ grate area	52.2	64.97	53.80	70.50	60.50	52.30	53.60	53.30	60.20	93.00	35.60	47.50	60.50	78.50	64.00	24.70	24.40	71 00
Firebox heat. surf. ÷ total H. S., %	7 54	6 10	6.80	5.30	6.30	7.60	6.60	6.75	6.15	6.90	6.60	6.30	6.10	6 80	5.10	8.40	8.90	8.65
Wgt. on drivers ÷ total heat. surf.	44.76	37.10	41.50	33.10	32.60	43.80	39.60	44.80	51.00	53.40	45.60	61.50	44.50	49.00	45.75	55.30	46 80	57.40
Wgt. total ÷ total heat. surf.	92.32	64.60	78.90	64.00	61.80	79.50	74.00	80.00	67.00	68.00	59.80	81.10	58.70	67.00	60.50	80.50	71.00	100.00
Total H. S. ÷ superhtg. heat. surf.						4.76		7.08				5.10						4.92
Cylinder volume, cu. ft	8.3†	11.40	10.2†	9.†	10.40	10.40	10.20	10.40	11.40	12.30	10.90	17.20	11.40	10.20	10.40	8.60	9.50	9.50
Total heat. surf. ÷ cyl. vol.	302.00	314 00	262.00	355.00	311.00	219.00	260.70	230.00	288.00	243.00	311.00	136.90	292.00	268.00	287.00	233.00	224.00	248.00
Sup. heat. surf. ÷ cyl. vol.						46.20		32.50				26.70						38.42
Grate area ÷ cyl. vol.	5.70	4.85	4.83	5.00	5.16	4.19	4.85	4.30	4.80	2.61	8.68	2.88	4.80	3.40	4 45	9.50	9.20	3.48
Reference in The American Engineer, year month page	1911 Feb. 44	1911 Apr. 126	1906 Aug. 308	1908 Jan. 37	1907 Dec. 471	1909 May 195	1905 May 154	1905 Sept. 329		1907 Dec. 481	1905 Nov. 407	1910 Feb. 64	1906 Feb. 59	1909 Feb. 52	1907 June 247			1910 Nov. 435

* Reheater Surface.

† Equivalant Simple Cylinders.

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CONTENTS

CONVENTION NOTES

Probably the most important action taken at the recent conventions was the appointment of the committee to recommend a design of standard M. C. B. coupler. Attempts of this kind have been periodically made for a number of years, and word that they at last have taken concrete shape will be received with great pleasure by all those who have to be connected with car repairs. The discussion on the floor of the convention leaves room for no doubt but what there is a sufficiently strong feeling on this subject to make its prospect of success very bright. The reports of various members would seem to indicate that many of the difficulties which have held back an attempt in this direction in the past are not as serious as have been thought. If this committee is successful, as is most certainly to be hoped it will be, in recommending a coupler standard in all its parts to the next convention, the 1911 meeting will not be lacking for an appeal to a prominent place in the history of the activities of this most important association.

The report of the committee on mechanical stokers before the M. M. Association brought out a very general and important discussion. It was clearly shown, as has been pointed out in these columns previously, that mechanical stokers will successfully fire a locomotive and are doing so at many different points. While this is most gratifying, it was shown that in at least one case a stoker which would successfully fire when in operation had been discarded because of lack of reliability. This important feature, together with information on methods of caring for the stoker and maintaining it, received surprisingly little comment. It is apparently too early in the experience of most members to discuss these features, which will eventually determine the continued use of different designs. In connection with fuel economy, so far as the amount of fuel used is concerned, the discussion showed that little can be expected when compared with the best hand firing. It was indicated, however, that considerable economy could be obtained by the successful use of lower grade and cheaper fuels.

The paper on superheating by Professors Benjamin and Endsley added a very important chapter to the most valuable volume of information which is being produced by the laboratories of Purdue University. The tests throughout showed conclusively what had already been claimed by many experts, that it is the higher degrees of superheat which give the real economies, i. e., the economy increases at a greater ratio than the degree of superheating, and so far the tests have not discovered the limits to this condition. The conclusive settlement of this point will be no doubt most gladly received by the motive power officials. Testimony of the members indicated wonderful results with superheat and the indications are that like all other appliances of advantage or economy after their value has been conclusively proven, superheat will be very rapidly and generally used throughout the country.

In the discusison of the paper on "Repair Equipment for Engine Houses" the statement of the committee in condemning the practice of using old, worn out and obsolete machine tools equipment at this point was strongly commended. It is hard to understand how a tool can be satisfactory for roundhouse use where the work must usually be done more quickly and under more difficult circumstances, which has been discarded as practically useless in the repair shop. This seems, however, to be a fairly general custom. If a tool is too small and light for doing the work at the main shop, where it can be kept in the best state of repair, the line of reasoning which proves it satisfactory for work on the same locomotives under roundhouse conditions was not explained by any of the advocates of this practice. The practice is common, but no members in discussing the report attempted to defend it.

Roundhouse conditions do not require the use of elaborate and complicated machines arranged for high production, but they do demand certain well built simple tools in perfect adjustment. Tools of this character are not so expensive, but what their purchase can be easily justified, when the cost of engine failures or delays at terminals is considered.

In this report the committee made a plea for the use of the term "enginehouse" instead of "roundhouse." It is very doubtful if this will be generally accepted. While in the beginning the term "roundhouse" was descriptive of the structure, its usage has been so common that it has come to be the general term for locations where a turntable is installed with an accompanying housing structure. The English language contains

many words of this kind which through a period of evolution have lost their exact original meaning, but which are accepted and thoroughly understood, becoming an integral part of the language. The advisability of changing a term which is perfectly understood, and is not at all confusing, simply because it is not now exactly descriptive, will probably not meet with general support. The term enginehouse has been used very generally in the columns of this journal during the past few years largely for the reasons advanced by the committee, but criticisms and arguments from our readers have convinced us that it is impossible and inadvisable to attempt to force it into general use, and the term "roundhouse" is now being employed exclusively as descriptive of a building wherein locomotives are stored, cleaned and repaired if it is served and accompanied by a turntable.

A question which has been uppermost in the minds of many superintendents of motive power in considering the application of superheaters has been the matter of lubrication, and in the beginning it was feared that this feature would prove a stumbling block for high temperature steam. Those applying superheaters at the start adopted forced feed lubricators and other methods to insure a proper supply of oil. The report of the committee this year on the subject of lubrication, however, condemns the forced feed lubricators and states that the common hydro-static lubricator will answer all purposes if the connections and the source of discharge are properly located. After reading the committee's report members who were present at the previous convention and visited the three-cylinder Atlantic type locomotive on exhibition at the Reading station, which uses superheated steam and is equipped with force feed lubricators, and has during the past year been most successfully operating at some of the highest speeds ever obtained in regular service, could not help but be impressed with the ten-wheel locomotive of similar design on exhibition this year, which was also equipped with force feed lubricators, indicating that in one case, at least, this method of lubrication had been satisfactory on very high speed runs with superheated steam.

Experience with injecting graphite mixed with oil in the valves and cylinders was reported as being very favorable, and it is probable that another year will develop many interesting features with this practice.

Members at this convention were greatly handicapped by the late date at which the reports were received, making it practically impossible for them to give any study or thought to the committee's work in most cases. This difficulty has existed in some degree every year, but was worse this year than previously. In the general discussion of the subject on the floor it developed that the fault for this could not be localized, that many things entered into it, and that the members in general were in a large measure to blame for the trouble. It is to be hoped that the experience this year will remain in the minds of members and that they will realize the importance of replying to committees circular letters promptly and fully and that the committees will meet early and frequently until their work is completed, so that the reports can be in the hands of the secretary complete by April 1st, as they should be.

A noticeable feature throughout the sessions was that there was more commingling in the discussions than has generally been observed heretofore. Passing in review the former years of these gatherings, it is well remembered that the various papers presented were discussed by possibly four or five members who had been identified with the positions of speakers since practically the incipiency of the organization, but on this occasion the younger element in railroading were not only called upon by the presidents, but volunteered the recital of their experience for the general good. This is exactly what it should be, as reliance must be placed to some extent at least upon the younger members of the mechanical profession for progressive ideas. This is not said in detriment of those who have taken the most active parts in these proceedings for so many years, and to whose good work these conventions undoubtedly owe their success, but simply to remind that without the injection of new ideas all such deliberations must become lifeless. This convention was noticeable for the fact that men were heard from on the floor who had never previously spoken before this body, and it is equally significant that the remarks essayed by these newcomers were conducive of more enlightenment on the various subjects and inspired a more general discussion.

RAILROAD INSPECTION IN OUTSIDE SHOPS

It is pleasing to note that the present selection of men for the position of inspector in car, locomotive and other shops where railroad work is under contract, appears to be dictated by considerably better judgment than prevailed in former years, and in nine cases out of ten the right man is now in the place. The latter has gradually become endowed with the importance which has long been denied to it, and in the improved order of things the results must be equally pleasing to both the builders and the railroads.

The farcical inspections of only a few years ago well illustrate that the matter is one which has worked out its own salvation, largely from the abuses into which it had fallen. A good machinist of those days was supposedly qualified to inspect the construction of say one hundred locomotives. It may be that he was a man who had never been in a shop other than his own, and had never spoken to a person higher in authority than his foreman or master mechanic, and this with the fact that his authority was ill defined, or not defined at all in many cases, made him of little consequence. Sometimes a draftsman would be selected as inspector, through presumed familiarity with the design of the cars or locomotives under contract, but very often with no shop experience whatever. Various unpleasant situations and complications were inevitable in such instances. It would frequently become necessary for the builders to appeal to the railroad companies, and the latter would reverse the inspector's decision, which implied, of course, his loss of prestige around those particular works for the future. No locomotive or car building concern in the country would ask an inspector's recall until the limit had been reached, and it is really astonishing the patience they have as a whole displayed in contending with incompetent and overbearing men, lightly clothed with brief authority.

Through the system of reform which has been worked, and in which no doubt the Pennsylvania and the Baltimore and Ohio railroads were the pioneers, a very superior class of men are selected to represent the railroads. They are shop men, essentially, but many have sufficient training to conduct the ordinary physical tests of material, are thoroughly familiar with drawings, and possess another sterling qualification in knowing how to properly approach those in authority. From the old plan of a day's pay while on duty at the builder's works they now receive good monthly salaries and expenses, and many of them are ranked with the grade of a general foreman.

Railroad inspection can be conducted pleasantly and profitably for all concerned when the proper man is secured and invested with the necessary authority. The lack of this latter, unfortunately, appears to be the still weak feature of the work. There is no reason for the stream of letters continually flowing between the builder's works and the superintendent of motive power's office, and it would never have started had the position and authority of the inspector been properly defined at the start. While it may be difficult, of course, to secure a properly qualified man in whom this implicit confidence can be reposed, it should not, nevertheless, be beyond the resources of a great railroad. The builders, contrary to a widely extended belief, welcome the presence of a competent inspector in connection with any contract, as he can settle many disputed points which may arise in connection with the interpretation of drawings, or manner in which work should be done. If he meets them half way he will always be so met in return.

Railroads in general are developing this branch of the motive power department, and they are to be congratulated on the great improvement which has been wrought.

Master Mechanics Association—Forty-Fourth Annual Convention

ABSTRACTS OF THE REPORTS OF THE COMMITTEES AND THE DISCUSSION THEREON PRESENTED AT THE CONVENTION HELD AT ATLANTIC CITY, N. J., JUNE 14-16.

The forty-fourth annual convention of the American Railway Master Mechanics' Association was opened on the Million Dollar Pier, Atlantic City, on June 14 with President Fuller (U. P.) in the chair. After prayer by Rev. Caldwell the Association was welcomed by Mayor Stoy in his characteristic style. Mr. Bentley (C. & N. W.) responded to the Mayor, after which the president presented his address, saying in part:

The year 1910-1911 has been a memorable one in so far as it relates to government legislation affecting the railways in general, and the mechanical department in particular. During this period federal laws have been enacted regulating safety appliances for railway equipment; also laws regulating the inspection and care of locomotive boilers. In some states there has been additional legislation, the full crew and caboose bills and headlight bills, while in addition to the federal legislation there has been in some parts of the east, state legislation with regard to boiler inspection. In view of the federal and state legislation on the same matters, it would seem every possible effort should be made to have the state laws either withdrawn or amended to agree with the government legislation.

In the matter of safety appliances your committee, in conjunction with the Master Car Builders' Association, has had this work in hand and has given a great deal of time to it, conferring with the government officials as well as representatives of the railway employees, and a set of rules was formulated covering the requirements.

In my opinion this association should insist on the Interstate Commerce Commission furnishing necessary drawings specifying in detail the location for safety appliances.

Your committee also gave considerable time and work to the boiler bill, and in conference with the government officials arrived at rules governing the matter.

As the work of your special committee on the Safety Appliance and Boiler bills has now been completed and as both of these have to do exclusively with technical matters which can properly be handled by mechanical men, it would seem the future work in connection with these matters should be taken over by the association, and I would recommend the appointment of a committee to handle it. In this connection I cannot too strongly recommend that the members of this association conform promptly to the requirements of the Safety Appliance and Boiler bills, which will indicate to the commission that the railways of America are ready to comply with the law if the requirements are clearly known.

It also appears to me that the requirements of the Safety Appliance act as well as the Boiler bill should be embodied in and adopted as the standards of this association.

In view of past legislation on matters pertaining particularly to the mechanical department, it would seem to me that the policy and work of this association should be more clearly outlined than ever before.

Our experience emphasizes the necessity for looking forward and taking such steps toward uniformity as will enable this association to take the initiative in these matters. I believe this is an opportune time for members of the association to get away from a great many of their personal opinions and get together and agree on the best standards and practices to a greater extent than ever before, and having arrived at such standards they should be followed. Uniformity and unity should be the keynote of our future endeavors.

I see no reason why this association should not have as a part of its recommended practices, mechanical plans for large and small terminals, units embodying the best practices, so that if conditions are such that these plans in their entirety are not feasible or practicable it will be possible to take therefrom the best available features under which shop lay-outs can be designed. There are a good many of the railways that do not employ large and expensive engineering forces and such plans would be of infinite value to such members.

A very pertinent subject in connection with the matter of increased efficiency, to my mind, is the education of our apprentices, in fact of all our employees. By what better method can we hope to increase our efficiency than by setting a high standard for the young men we are educating, from whom we must be able to draw our foremen and shop managers? Progress has been made by some of the individual lines not only in the ways of educating apprentices, but also giving other employees similar advantages by instituting plans of broad scope with educational bureaus open to all employees. It is my opinion that in line with these efforts our association should adopt a recommended apprentice system for apprentices to the various trades as well as for the technical graduates, commonly called "special apprentices."

On the recommendation of my predecessor a committee was appointed in connection with the establishment of a permanent technical bureau within our association. Such a bureau cannot help but be a valuable asset of this association and I cannot too strongly endorse the wisdom of this plan, which I hope will be carried out at an early day. I have indicated the work which has been accomplished by the special committee which conferred with the government officials in the matter of safety appliances and the boiler bill. This simply illustrates what can be done and the value of a centralized bureau to handle subjects which are of a mechanical nature is, it would seem to me, very apparent.

By invitation this association had a representative in attendance at the annual meeting of the Conservation Congress. The aim and work of this congress are something in which every member of this association is vitally interested, and I believe it should have our co-operation and support in every way possible.

The question of consolidating this association with our sister association, the Master Car Builders', has been discussed for some years, and there has been considerable agitation of the matter for the last three years. Committees have been appointed, but up to the present time the proposition has not been settled. It has been the opinion of a great many of the members that the consolidation of the two associations was not feasible and practicable and I leaned to this opinion, but the more I have studied the subject the more I have become impressed with the idea that the union of these two associations will enable us to carry on the work in a far more satisfactory manner. Those of us who have worked in both associations realize what an extra amount of work and time two associations mean for the individual members, and I personally feel the time is ripe for this consolidation or union of the two associations, and I believe the committee should be so instructed to perfect plans so that this consolidation can be accomplished as quickly as possible.

There are a number of important matters confronting railways at this time which should receive our earnest attention and co-operation. We have under consideration and have had committees appointed to investigate during the past year some fifteen subjects comprising important mechanical problems of to-day, and I trust that the reports of the committees will be carefully analyzed and freely discussed to obtain the full benefit of the able work which has been done.

I would call particular attention to the report of the commit-

tee on Design and Construction of Locomotive Boilers. In my opinion this association should arrive at such standards for boiler design as will be adopted and followed by all members.

ASSOCIATION BUSINESS

Secretary Taylor presented his report, which showed that the active membership in June, 1910, was 952; since that time there were transferred to honorary membership, 6; deaths, 11; resignations, 13; dropped for non-payment of dues and mail returned, 1; being 31 deductions from the list as it appeared in June, 1910. During the year there were 78 new members elected and one member reinstated, making the total membership at the present time 1,000. The associate membership is 20, the same as in 1910. The honorary membership is 43, being an increase of 6 since 1910. The total membership is now 1,063. The following deaths have been recorded: Active members: D. F. Van Ripper, H. H. Johnson, J. B. Gannon, A. J. Dunn, David Brown, Wm. Buchanan, H. S. Bryan, G. J. DeVibiss, P. G. Thomas, J. P. Picciolo and S. K. Hatah. The secretary presented the treasurer's report, which showed an income of $6,036.90, and expenses of $5,940.77, leaving a balance of $96.13.

Prof. Louis E. Endsley, Purdue University, and E. A. Averill, managing editor of this journal, were elected associate members of the association.

The association has four scholarships at the Stevens Institute of Technology. There are no vacancies at the present time and there will not be any until September, 1912. The scholarship at Purdue University given by Joseph T. Ryerson & Son, for which they appropriate five or six hundred dollars a year, takes care of the school expenses as well as boarding the student. The present student graduates this spring, and the Ryerson people are willing to extend this another four years if the association desires to co-operate with them. The executive committee accepted this offer.

ELECTION OF OFFICERS

The following officers were elected for next year:

President, H. T. Bentley, Chicago & Northwestern.

First vice-president, D. F. Crawford, Pennsylvania Lines.

Second vice-president, T. Rumney, Erie.

Third vice-president, D. R. MacBain, Lake Shore & Michigan Southern.

Treasurer, Dr. Angus Sinclair.

Executive Committee members, C. A. Seley (C. R. I. & P.), E. W. Pratt (C. & N. W.) and J. F. Walsh (C. & O.).

MECHANICAL STOKERS

Committee:—T. Rumney, Chairman, E. D. Nelson, C. E. Gosset, J. A. Carney, T. O. Sechrist.

The committee feels justified in expressing the opinion that such progress has been made in the development of mechanical stokers as to warrant railroads installing a limited number upon large locomotives at least, and thus lend their aid in the perfection of a device which the committee has concluded is a necessary appliance to heavy tractive-power locomotives, when such locomotives are called upon to exert their full capacity for a prolonged period.

The large locomotives at present being constructed would unquestionably render service nearer their maximum capacity if the firing were mechanical, and the committee is of the opinion that it behooves the members of this association to participate actively by utilizing such stokers as have been developed, and, by actual application, assist in the solving of the many problems which must naturally present themselves during practical operation.

The requirements for mechanical stokers, as recommended by the committee, in brief, are:

That they should be capable of firing coal in excess of the maximum requirements of the locomotive;

That the fire-box door be free of any attachment which would prevent the fireman from giving such attention as fires may require;

Be entirely mechanical from tender to grate;

Be capable of handling bituminous run-of-mine coal, which will include a coal crusher, mechanically operated, on the tender;

Distribute the coal in the fire-box in such a manner as to call for no assistance from the fireman other than regulation of supply and possibly the adjustment of the mechanical appliances for distribution;

Maintain an ideal fire for economic coal consumption without emission of black smoke in objectionable quantities;

Reliability of service.

Previous reports of the committee have directed attention to various mechanical stokers under development, and a summary upon each is presented, with such remarks as are believed pertinent to the subject.

CRAWFORD UNDERFEED STOKER.

This stoker is in service on the Pennsylvania Railroad; its operation has been satisfactory; it is completely mechanical and aims to cover every requirement set forth.*

BARNUM UNDERFEED STOKER.

This machine is in the process of development and so far has been used as a distributor only, requiring coal to be shoveled into the hopper.

The reports from the Chicago, Burlington & Quincy Railroad indicate that the mechanism operated satisfactorily burning an inferior grade of fuel, showing economic results. It is in successful operation on a six-wheel switch engine and a Prairie type freight engine.

A method of crushing coal on the tank and delivering it to the hopper on the engine is now being developed which will make the device meet all the requirements enumerated.

STROUSE OVERFEED STOKER.†

The committee is not able to report fully thereon.

The manufacturers have increased the scope of the apparatus, which formerly consisted of a distributor only, by adding a conveyor from tender.

Satisfactory service has been obtained with regular crews, but the development to date does not permit of complete report.

STREET OVERFEED STOKER.‡

There are ten machines in service, including four on the Lake Shore & Michigan Southern Railroad, one on the New York Central Railroad and the remainder distributed on five other railroads.

The stoker is designed to meet every requirement suggested by the committee, and is successful in its operation.

HANNA OVERFEED STOKER.§

The stoker has been developed only as a distributor.

Consequently, it falls short of the requirements set forth, inasmuch as run-of-mine coal cannot be handled, and shoveling from tender to a hopper is necessary.

The device distributes coal into the fire-box very satisfactorily and is rendering good service on the Queen & Crescent Railroad, operating on Mallet, Consolidation and Pacific type locomotives.

HAYDEN STOKER.¶

The original design failed in two particulars, unreliability and poor design of conveying mechanism and the burning out of coal-distributing plate.

The modified distributor developed independently from the conveyor avoids the distributing coal plate in the fire-box and is giving satisfactory service on the Erie Railroad.

DICKINSON OVERFEED STOKER.

This is a further development of the principle involved in the Hayden stoker and seeks to fulfil the requirements of the committee.

It is in operation on the Erie Railroad and giving satisfactory results in regular freight train service.

BREWSTER UNDERFEED STOKER.

One of the above was recently applied to a locomotive on the Erie Railroad, but owing to modification being required the time was too limited to permit of the results being included in this report.

The stoker is designed to meet all requirements previously mentioned.

It consists in part of a screw placed in the bottom of the tender and covered with movable steel plates, so arranged that a gradual flow of coal is admitted to the screw. The coal is conveyed by means of this screw through flexible coupling to a point below the grates. It is then carried upward through the grates by means of a second screw to the steam jets which are on a level with the bottom of the fire-box door. The blasts from the jets, which work intermittently, are adjustable to meet any condition of fuel or size of fire-box.

The grates are divided into four divisions, two on each side, and by means of a cam—one section at a time—they are tilted slightly forward to advance the fire and agitate the grates sufficiently to keep clear of ashes.

The whole arrangement is operated by a small double-cylinder engine, located on the left side of the locomotive, below the cab.

SUMMARY REMARKS.

This report does not include any tests comparing efficiency

* See AMERICAN ENGINEER, May, 1911, page 161.
† See AMERICAN ENGINEER, April, 1908, page 151.
‡ See AMERICAN ENGINEER, June, 1911, page 232.
§ See AMERICAN ENGINEER, April, 1911, page 121.
¶ See AMERICAN ENGINEER, April, 1908, page 147.

of mechanical stokers to hand firing, as the committee believes that mechanical stokers must be made flexible and reliable machines before any prospects of improved economy in fuel consumption may be expected.

Tests comparing inferior fuel used with mechanical stokers to regular supply for hand firing, thus taking advantage of difference in present fuel values, should not be accepted as proof of economy, as such relations would not maintain with the extension to any appreciable number of mechanical stokers.

The progress during the past year has been sufficiently marked to lead the committee to believe that it can present a final report at the next convention upon at least several of the stokers which have already been developed sufficiently to perform actual continuous service.

Discussion.—This subject brought forth one of the most general and active discussions of any during the convention. Most of the speakers reported on what the stokers were doing in connection with keeping up steam, and practically nothing was mentioned concerning the principles of construction, features of design or methods of caring for them at terminals. The evidence was overwhelming that all of the three principal designs of stokers will fire a locomotive with reasonable reliability.

In reference to a qestion C. B. Young (C. B. & Q.) stated that the Barnum stoker was being tried experimentally with some degree of success. It worked well on a switch engine, but some difficulty had been encountered on road engines.

George A. Hancock (S. L. & S. F.) reported successful service with a large Mallet locomotive fitted with a Street stoker.

T. O. Sechrist (Q. & C.) reported eight engines fitted with Hanna stokers, one, a Mallet, having been in service with a stoker for fourteen months, during which time there had been but two failures, both due to the carelessness of the crew. All eight stokers on different types of freight and passenger service were operating most successfully, handling from 5,000 to 0,000 pounds of coal per hour.

George L. Fowler gave a report of a recent most remarkable trip he had made on a consolidation locomotive fitted with a Hanna stoker. On this occasion the fireman was an inexperienced man, not only with the stoker, but also on a locomotive, but the trip was a record breaker and at no time was there the slightest difficulty with steam pressure or with the operation of the stoker.

In respect to the present status of the stoker, Mr. Fowler, who has made a study of the operation of the three most prominent designs, said:

"In adopting the use of the stoker the men should be given some idea of what they are going to use, what the stoker is for, how it works, and then have the roundhouse forces take care of the stokers. Give the stoker the proper kind of coal, and if you do that, with any of the three stokers now on the market, there is no reason why an engine should not be fired perfectly. I think that the firing can be done more economically with the stoker than it can be done by hand firing."

C. E. Chambers (C. R. R. of N. J.) stated that on a trip with the Crawford stoker he had found the work of the machine to be absolutely perfect so far as steam pressure, absence of smoke, and convenience were concerned.

In speaking of the design of stoker credited to him, D. F. Crawford (Penn.) said in part:

"We have made all told 2,000 trips with the stoker. Of these about 1,600, representing very roughly 160,000 miles, have been made with what might be called the improved stoker. There are at present about 20 locomotives equipped. There are 19 in regular service and we have 10 or 12 more under way. The stokers have all been applied, with the exception of three, to H-6 consolidation locomotives. Two of the stokers are placed on a larger consolidation locomotive and one on a switch locomotive.

"The stokers up to three or four months ago were in the hands of regular crews; in some cases a man rode with them. He was called a stoker instructor, and was simply a fireman who had been taught what the different parts consisted of and what was expected to be done with them. It was his duty to teach the other firemen how to handle the stoker. About three or four months ago five or six of the locomotives were assigned to one division and were turned over to the pool. Out of 1,500 or 1,600 trips that the latest stokers have made, about 800 of them have been 100 per cent. stoker fired; that is, no coal was put in by the shovel at all. One thousand trips have been about 90 per cent. stoker fired or over, and the average of all trips is somewhere about 90 per cent.

"The stoker has been on the testing plant at Altoona. We have made a number of tests with the Salinville coal, which we use regularly, and we have succeeded in firing 6,300 pounds of coal per hour. We have fired that successfully and maintained the steam pressure with it; the performance was in every way satisfactory. I agree fully with the conclusions of the committee as to the desirable points of the stoker. I disagree with Mr. Sechrist, who said that the conveyor should not be used. The stoker is not complete unless it does the whole job. The first stokers that we had were without the conveyor, and they did not appeal to me as meeting the situation.

"Something has been said about coal economy. From the results obtained on our testing plant I think we will do as well, or even better, than the best hand firing. On some of the tests that we have made the stoker has shown conclusively that it will save coal as compared with the average hand firing. However, I do not look to coal saving in itself as being the important point of the stoker. To me the important point is to be able to rate your locomotive not on the size of the cylinders, but on the pounds of coal that it burns. Our consolidation locomotives are probably using from 3,000 to 4,000 lbs. of coal per hour in regular service over a continued run. We want to rate those engines at 5,000 lbs. of coal per hour, and make the train behind the engine a 5,000 lbs. of coal per hour train and do what such a train ought to do We do not have to build any heavier or bigger engines. All we have to do is to burn more coal and use the engine that we have up to its adhesive ratio."

C. F. Street reported that there were now ten of his stokers in service. He said that in several cases the application of the stoker had increased the capacity decidedly, in one case from 15 to 20 per cent., and that it was this feature that should be the main argument for the use of stokers. Another feature is the increased speed. Stoker engines work on grades where hand fired engines will not. He spoke strongly in regard to the instruction of the firemen in the use of the stoker and to the proper arrangements for taking care of them in the roundhouse. In his opinion a stoker to be successful must be able to handle any quality of fuel furnished it.

M. H. Haig (Santa Fe) expressed himself as surprised at the uniformity of the favorable reports inasmuch as his experience with three designs of stokers, the Street, Hanna and Strouse, were quite different. They all were extravagant on fuel and had difficulty maintaining steam pressure.

J. F. Devoy (C. M. & St. P.) said that after a year's experience he could say nothing complimentary for the Strouse stoker. He agreed with the committee that a conveyer should be provided.

G. A. Hancock said that they had considerable trouble with a Street stoker at the beginning, but after the firemen became accustomed to it the trouble disappeared.

T. Rumney (Erie) advocated the conveyor as a necessity, stating that he had worked four years to get a satisfactory design.

SAFETY APPLIANCES

Committee:—Theo. H. Curtis, M. K. Barnum and C. B. Young.

[The report was confined largely to quoting the orders of the Interstate Commerce Commission dated March 13, 1911, regarding sill steps, handholds, uncoupling levers, couplers, end ladders, running boards, etc., for locomotives in the different classes of service, viz., switching or road. Copies of the original order can be obtained upon request to the Interstate Commerce Commission.—ED.]

Theo. H. Curtis (L. & N.), chairman of the committee, suplemented the report as follows:

Referring to the Interstate Commerce Commission standards for steam locomotives in road service and the location of the sill steps, there have been a great many questions asked as to where the roads are going to place this sill step. The order is very plain that it must be outside of the rail, and not over 16 in. above it. It may be placed on the face of the bumper beam, or it may be placed on the rear of the bumper beam, or it may be placed on the pilot; so long as it is outside of the rail and not over 16 in. above the rail, it complies with the law. There are some railways that use this step entirely, where the clearance will permit it, on the rear of the bumper beam. Other railways use it and have the same attached to the pilot. Some are applying it on the face of the bumper beam. I wish to

call your attention to the fact that this sill-step is to have a metal tread 8 in. by 10 in. It says it also may have a wooden tread. My interpretation of this is that sill step must have a metal tread. If you wish to put a wooden tread on top of it you can.

The pilot beam handholds and rear-end handholds for steam locomotives in road service are to be ⅝ in. in diameter with a minimum clear length of 14 in., preferably 16 in., and minimum clearance of 2½ in. The end handhold for steam locomotives used in switching service must be 1 in. in diameter, with 4 in. clearance, except at coupler casting or braces, when minimum clearances shall be 2 in. Under the location we learn that this handhold shall extend across the front end of the locomotive, in the rear of the tender. You will note that the road engine has a different handhold from the switch engine. There is nothing said in the order as to when the road engine becomes a switch engine, but it is reasonable to understand that a road engine could not switch too long and not become a switch engine; therefore it becomes almost necessary to equip your road engine as a switch engine in order that you may transfer a road engine to switch engine service. The handholds on a switch engine would be permissible on a road engine, but the handholds on a road engine would not be permissible on a switch engine.

The important feature of the end clearance is the 14 in from the vertical plane passing through the inside face of knuckle when closed with the horn of coupler against buffer block or end sill. There are exemptions made for air hose, steam hose and different appliances, but there are no exemptions made for bolt heads, rivets or push pole pockets Therefore the matter stands about like this: There are 14 in. required by law; about half an inch will have to be added for contingencies, 3 in. will need to be added for push pole pockets and other parts of the tender that are not exempt, and 2 to 3 in. clearance must be added for compression of the spring, making a total distance of about 20½ in. from the end sill to the inside of the knuckle. Now, this is a very long overhang to maintain on a switch engine. Especially is this so when it is required on a switch engine, and a road engine may be made a switch engine almost momentarily. So it becomes practically necessary to equip a road engine with a very long distance between the knuckle and the end sill. With this long overhang, or distance, we begin to have some more trouble. The uncoupling lever arm will be very long, it may be 15 to 18 in. long. In fact, it is so long that it is very hard to lift the knuckle. This uncoupling apparatus must extend near the full width of the tender; there is very little allowance left. There is nothing said in the law as to the length of the arm on the outer end of the uncoupling lever as it applies to locomotives, but there is as applied to cars. It is open to reasonable interpretation that this lever must not be too long. If it is too long, when the trainman on one side of the tender or pilot raises the uncoupling lever the long handle will stick out on the other side and perhaps injure a fellow-trainman.

These difficulties must needs be obviated after a very careful study of this safety appliance question and after, I might say, a conference of your best men in an endeavor to ascertain how it can be applied to your locomotives. I have held several of these conferences with the officials of the road with which I am connected, and we feel that we have learned a great deal about the application of safety appliances, but we believe there is still much more to learn.

Discussion.—The president drew attention to the requirement for increased length of drawbar head on tenders, and it was explained by Mr. Wilden that the committee of the M. C. B. Association would make a report covering this.

C. A. Seley (C. R. I. & P.) spoke on the requirements covering engines used in switching service, which seemed to practically include all freight locomotives as well as switching locomotives. He recommended that all road engines be fitted up under the switch engine requirements so far as handholds and clearances are concerned. The tapered front buffer beam proved to be of considerable advantage in obtaining the required clearance where a man stands.

J. H. Manning (D. & H.) recommended that no new coupler head be adopted, but that the yoke be lengthened and filling blocks be inserted to give the required clearance.

Mr. Curtis stated that he had attempted without success to use the standard coupler head with an increased length of yoke. He believed a new head measuring 13½ in. from horn to face of knuckle was the solution.

LOCOMOTIVE PERFORMANCE UNDER DIFFERENT DEGREES OF SUPERHEATED STEAM

BY C. H. BENJAMIN AND LOUIS E. ENDSLEY.

The work done by Dean W. F. M. Goss, reported by him to this Association in 1909, and the further work done by the authors of this paper, reported to the Association in 1910, seemed to show a progressive improvement in the efficiency of the locomotive with an increase of superheat. It was also apparent that the improvement in the efficiency had not reached a maximum, but continued to grow as the temperature of superheat increased. For this reason, it seemed desirable to attempt still higher temperatures, and to determine, if possible, any maximum point in the curve of efficiency. The locomotive Schenectady No. 3 has accordingly been equipped with a Schmidt superheater, giving substantially more superheating surface than the ones formerly used, as may be seen by reference to figures in this report. This has rendered possible the use of still higher temperatures, so that, whereas in previous experiments a maximum of about 200 degrees of superheat was obtained, from 200 to 275 degrees were used in the experiments described in this report.

Two conditions were to have been expected in these experiments: first, practical difficulty with the lubrication of the slide valve; second, less rapid improvement in economy at the higher temperatures. Neither of these conditions has been realized. Practically no difficulty was experienced with the lubrication of the valve, and no maximum of economy has been reached. As far as the figures and tables in the present report are evidence, the coal consumption decreases more and more rapidly as the superheat becomes higher. There seems to be no practical limit to the gain to be obtained in this way, except the usual troubles incident to the use of superheated steam.

The present report is shaped largely on the lines of that made by the authors last year in order to facilitate comparison. Although these experiments are not yet completed, it has seemed advisable to call to the attention of the Association the results so far obtained.

EQUIPMENT.—The same locomotive, now known as Schenectady No. 3, was used in all the tests. When used with saturated steam the locomotive was in normal condition. After the tests on saturated steam had been completed it was first equipped with a Cole superheater, and the results from tests of superheated steam, as reported to the Master Mechanics' convention in 1909, were obtained with the original superheating surface of 193 square feet (neglecting header). The work as reported last year was from results obtained after reducing the superheating surface by two successive decrements of 42 square feet each, or approximately 21 per cent. at each reduction.

Prior to the experiments described in this report, the locomotive had been overhauled and a Schmidt superheater installed in place of the Cole superheater, in order to distinguish between the different superheaters as used on Schenectady No. 3, in last year's report, the first superheater was known as "Cole A," the second as "Cole B," and the third as "Cole C." The superheater in this year's report is referred to as the Schmidt. The heating surface of the tubes of the four superheaters are:

Cole A, 193 square feet; Cole B, 151 square feet; Cole C, 109 square feet; Schmidt, 324 square feet.

The boiler dimensions were the same for all the Cole superheater tests, but in order to install a Schmidt superheater, with a larger amount of superheating surface, the number of small 2-inch flues was reduced from 111 to 107, and the large 5-inch flues were increased in number from 16 to 21. This change in the number of flues increased the water-heating surface from 897 square feet to 956.5 square feet. With the above exceptions, the boiler and engine were the same for all the testing upon the four different superheaters.

The nominal dimensions of Schenectady No. 3, as used in the tests with the Schmidt superheater, are as follows:

Type	4-4-0
Total weight about	109,000 lbs.
Weight on four drivers about	61,000 "
Driving-axle journals:	
Diameter	7½ in.
Length	8½ "
Drivers, diameter	68 99 "
Valves—Type, Richardson balanced:	
Maximum travel	6 "
Outside lap	1⅛ "
Inside lap	0 "
Ports:	
Length	12 "
Width of steam port	1 5 "
Width of exhaust port	3 "
Total wheel base	23 ft.
Rigid wheel base	8.5 "
Cylinders:	
Diameter	16 in.
Stroke	24 in.
Boiler—Style, extended wagon top:	
Diameter of front end	.52 "

Number of 2-inch flues	107 "
Number of 5-inch flues	21 "
Length of flues	11.5 ft.
Heating surface in flues	956.5 sq. ft.
Heating surface in fire box	123.5 " "
Total water-heating surface	1080.0 " "
Length of fire box	72.06 in.
Width of fire box	34.25 "
Depth of fire box	79 "
Grate area	17 sq. ft.
Thickness of crown sheet	7/16 in.
Thickness of tube sheet	9/16 "
Thickness of side and back sheet	3/8 "
Diameter of stay bolts	1 "
Diameter of radial stays	1 1/8 "

The Schmidt superheater, as used in these experiments, has the following dimensions:

Outside diameter superheater tube	1 3/8 in.
Number of double return loops	21
Average length of the pipes in the double return loops	42.8 ft.
Total superheating surface, based on the outside surface of the tubes	324 sq. ft.

The total water and superheating surface of the locomotive equipped with the Schmidt superheater is 1,404 square feet.

TESTS WITH SCHMIDT SUPERHEATER.

Following the method primarily adopted, the tests on the Schmidt superheater were run at 200, 160 and 120 pounds pressure. The tests at 240 pounds were omitted because it was felt that there was no further need of tests at this high steam pressure. The speeds and cut-offs adopted for the tests were the same as those used last year. These tests were all run during the months of April and May of this year.

Lubrication of the Valves and Cylinders.—Because of the fear expressed by several railroad men, that the lubrication of the valves, which are slide valves, would be difficult when using a higher degree of superheat, a transfer filler was added to the lubricator, thus increasing its capacity. After a few tests, however, it was found that no more oil was required with the Schmidt superheater than was used with the Cole superheater.

The oil used in all of the superheater tests was 600 W. The amount of oil used was approximately one drop (through a sight-feed lubricator) to each valve box for each 12 to 30 revolutions of the locomotive, and one drop to each cylinder for each 30 to 60 revolutions of the locomotive, depending upon the length of valve travel. That is, a short cut-off and high steam pressure required more oil than a long cut-off and lower steam pressure. The amount of oil used in a 75-mile run (this being the length of each test) varied from 1½ pints to 3 pints. This amount of oil may seem rather high to a railroad man, but to insure against the cutting of the valve, more oil was used than was really necessary, as was shown by the fact that during none of the tests was there any evidence of dry valves. An inspection of the valves and cylinder wall after all the tests had been completed showed a high polish and no cutting.

Evaporative Efficiency of the Combined Boiler and Superheater.—The first fuel used in all tests was Youghiogheny lump. The equivalent evaporation (pounds of water evaporated from and at 212° F.) per pound of dry coal, plotted against rate of evaporation (equivalent evaporation per foot of water-heating and superheating surface per hour), is given by the equation

$$E = 12.45 - .318\ H$$

where E is the equivalent evaporation per pound of dry coal and H is the equivalent evaporation per square foot of water-heating and superheating surface per hour. The area of the heating surface is based upon the interior surface of the fire box, and the exterior surface of the boiler and superheater tubes. This equation is derived from all tests at all pressures, and, therefore, fairly represents the average performance of the boiler at any pressure. It is to be noted that a majority of the points which represent individual tests fall very near the average line, which was obtained by finding the center of gravity of two groups of points and drawing a line through the two points thus found.

The Degree of Superheating.—The method of measuring the temperature of superheated steam was the same as that employed in the tests of the other superheaters. High-grade mercurial thermometers were placed in thermometer wells in the branch pipe at a point directly adjoining the superheater header. The equations for the lines plotted showing the superheating degrees Fahrenheit plotted against the rate of evaporation are given below in Table I. In order to obtain a common slope for all lines for all pressures, the points were averaged in two groups and the dotted line through these two average points used as the common slope. Other lines were then drawn parallel to this line through the points corresponding to each pressure.

TABLE I.

DEGREES SUPERHEATING UNDER DIFFERENT PRESSURES.

Boiler Pressure.	Equation.
120	$T = 107 + 16.5\ H$
160	$T = 101 + 16.5\ H$
200	$T = 90 + 16.5\ H$

In the above table T equals the superheating degrees F, and H equals the equivalent evaporations per square foot of water and suprheating surface per hour. Assuming a rate of evaporation which will give approximately 440 indicated horse-power, which is 8.5 pounds, the corresponding values of T for the various pressures can be obtained. The value of superheaters is expressed for the Schmidt superheater by the equation

$$T = 133.8 - .216\ P + 16.5\ H$$

where T equals the superheat in degrees Fahrenheit, P equals the boiler pressure in pounds gauge and H equals the equivalent evaporation per square foot of heating surface per hour. The above equation is applicable for any pressure and any rate of evaporation.

The Ratio of Heat Absorbed per Square Foot of Superheating Surface to that Absorbed per Square Foot of Water-heating Surface.—If the efficiency of the superheating surface be expressed as a ratio of heat transmitted through it to the heat transmitted through the water-heating surface of the boiler, or as the ratio of the equivalent evaporation per square foot, and this ratio be plotted for each test against the corresponding equivalent evaporation per square foot of water-heating surface per hour, it is seen that the efficiency of the superheating surface is increased with increase in the rate of evaporation. It is worthy of note that the efficiency of the superheating surface is equal to fifty per cent. of that of the water-heating surface when the equivalent evaporation per square foot of water-heating surface per hour is 13 pounds or more.

STEAM PER INDICATED HORSE-POWER PER HOUR.

SUPERHEATER	BOILER PRESSURE POUNDS BY GAGE	SUPERHEAT DEGREES F	POUNDS STEAM PER INDICATED HORSE-POWER PER HOUR	B.T U. PER INDICATED HORSE-POWER PER MINUTE
I	II	III	IV	V
SCHMIDT "A"	240	222.2	19.5	421.4
SCHMIDT "A"	220	226.5	19.0	410.7
SCHMIDT "A"	200	230.8	18.9	408.3
SCHMIDT "A"	180	235.1	18.7	404.0
SCHMIDT "A"	160	239.4	18.9	408.0
SCHMIDT "A"	140	243.8	19.5	419.8
SCHMIDT "A"	120	248.6	21.0	452.3
COLE "A"	240	139.7	22.6	474
COLE "A"	220	145.0	21.8	459
COLE "A"	200	150.3	21.6	455
COLE "A"	180	155.6	21.9	461
COLE "A"	160	160.8	22.3	468
COLE "A"	140	166.1	22.9	481
COLE "A"	120	171.4	23.8	497
COLE "B"	240	120.6	22.6	469
COLE "B"	220	126.8	22.1	460
COLE "B"	200	133.0	21.8	454
COLE "B"	180	139.2	22.1	460
COLE "B"	160	145.4	22.5	469
COLE "B"	140	151.5	23.0	479
COLE "B"	120	157.7	23.8	496
COLE "C"	240	109.9	22.7	469
COLE "C"	220	114.6	22.5	465
COLE "C"	200	119.4	22.6	467
COLE "C"	180	124.2	22.8	472
COLE "C"	160	128.9	23.5	486
COLE "C"	140	133.7	24.0	496
COLE "C"	120	138.4	24.8	512
NONE	240	0	24.7	483
NONE	220	0	25.1	491
NONE	200	0	25.5	498
NONE	180	0	26.0	507
NONE	160	0	26.6	517
NONE	140	0	27.7	537
NONE	120	0	29.1	563

TABLL II.

Smoke-box Temperatures.—The temperature of the gases in the smoke box was obtained by the use of a mercurial thermometer placed midway between the diaphragm and the front tube sheet. The equation of the line drawn through the points plotted between the smoke-box temperature for each test and the rate of evaporation is

$$T = 500 + 13.08\ H$$

where T equals the smoke-box temperature in degrees Fahrenheit, and H equals the rate of evaporation.

A COMPARISON OF RESULTS OBTAINED WITH SATURATED AND WITH FOUR DIFFERENT DEGREES OF SUPERHEATED STEAM.

Basis of Comparison.—As was pointed out last year, it seems logical to compare the four different degrees of superheated steam with that of saturated steam, since all the series of tests so far run have been under the same steam pressures and cut-offs, developing approximately the same horse-power, the only difference being the area of the superheating surface and the area of the water-heating surface. As the area of the water-

COAL CONSUMPTION UNDER DIFFERENT PRESSURES AND SUPERHEATERS.

BOILER PRESSURE POUNDS GAGE	POUNDS OF COAL PER INDICATED HORSE POWER PER HOUR				
	SATURATED STEAM	SUPERHEATER COLE "A"	SUPERHEATER COLE "B"	SUPERHEATER COLE "C"	SUPERHEATER SCHMIDT "A"
I	II	III	IV	V	VI
240	3.31	3.12	3.24	3.20	2.63
220	3.37	3.00	3.16	3.16	2.57
200	3.43	2.97	3.11	3.18	2.55
180	3.50	3.01	3.16	3.22	2.51
160	3.59	3.08	3.24	3.35	2.55
140	3.77	3.17	3.33	3.45	2.63
120	4.00	3.31	3.48	3.60	2.82

TABLE III.

heating surface of the boiler with the Schmidt superheater is approximately only 47 square feet greater than with the Cole superheater, it would seem that this difference would not be enough to affect the relative efficiency of the boiler. In the comparisons which follow, therefore, no allowance is made for differences resulting from different water-heating surfaces.

In the tables anad diagrams which follow, all material included under "Saturated Steam" and superheater "Cole A" has been taken directly without change from the 1909 report, and that under superheaters "Cole B" and "Cole C" from the 1910 report.

Comparison of Engine Performance.—The steam consumption of the locomotive operated under saturated steam and the four different degrees of superheated steam represented by "Cole A," "Cole B," "Cole C" and "Schmidt," are shown graphically in Fig. 1. The numerical values are given in Table II. From an inspection of these curves, it is seen that the tests with the Schmidt superheater, that is, the one giving the highest degree of superheat, gave the lowest water consumption.

The curves showing the relation between the B. T. U. per I. H.-P. per minute for the different conditions of tests are given in Fig. 2.

The relation in coal consumption per I. H.-P. per hour for the four different superheaters and for the saturated steam is shown graphically in Fig. 3, the numerical values being given in Table III. Here again the Schmidt superheater results are the smallest, going as low as 2.5 pounds per indicated horse-power per hour

The consumption of water per indicated horse-power as affected by the degree of superheat, is well shown in Fig. 4, in which the pounds of steam per indicated horse-power per hour are plotted against the degrees of superheat. The pounds of steam per indicated horse-power per hour were obtained from the curves shown in Fig. 1. It will be seen that the comparisons are made at 160, 180 and 200 pounds steam pressure, these being the pressures that fall in the center of the field of experiment, and for that reason would be more likely to represent correct results.

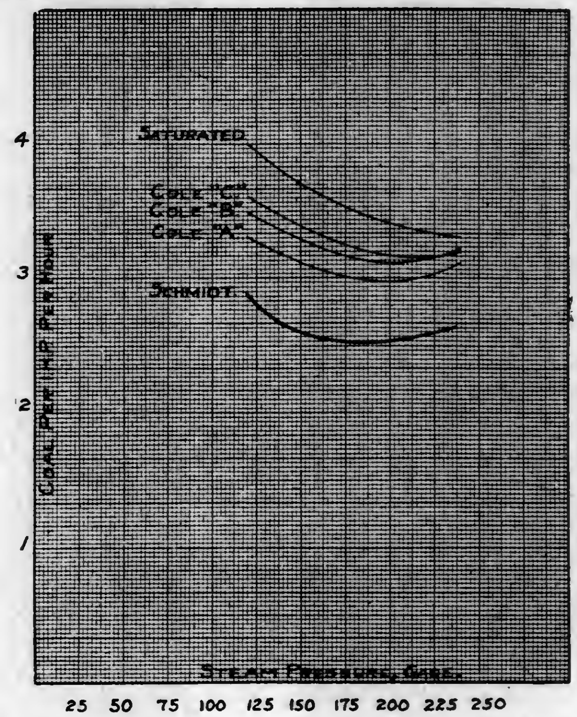


FIG. 1.

As indicated last year, it would seem that this relation could be approximately represented by a straight line as shown. It is also seen that the water consumption for all pressures between 160 and 200 pounds for the Schmidt superheater is practically the same.

Coal Consumption.—The pounds of coal per indicated horse-power per hour plotted against degrees of superheat are shown in Fig. 5. The pounds of coal per indicated horse-power per hour were obtained from the curves of Fig. 3, and the degree of superheat was obtained in the same manner as for Fig. 4.

The same pressures of 160, 180 and 200 were used in this comparison as in the comparison for steam consumption. This

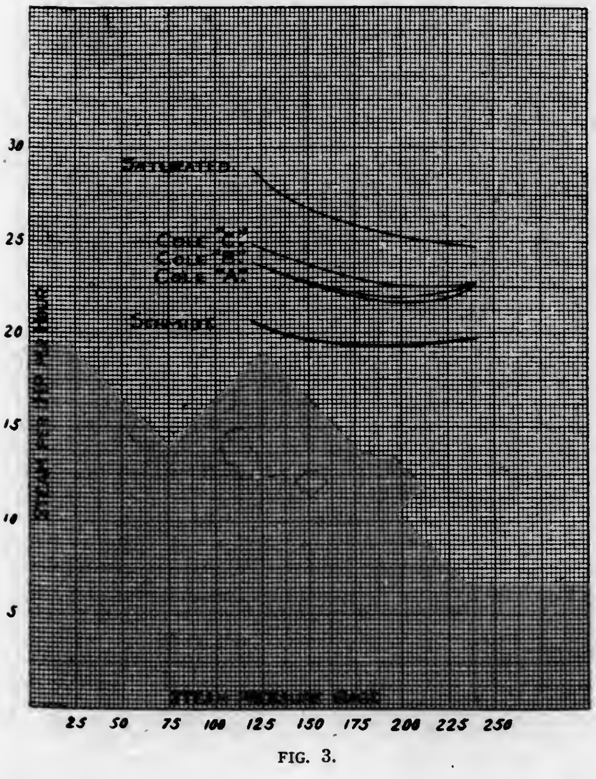


FIG. 3.

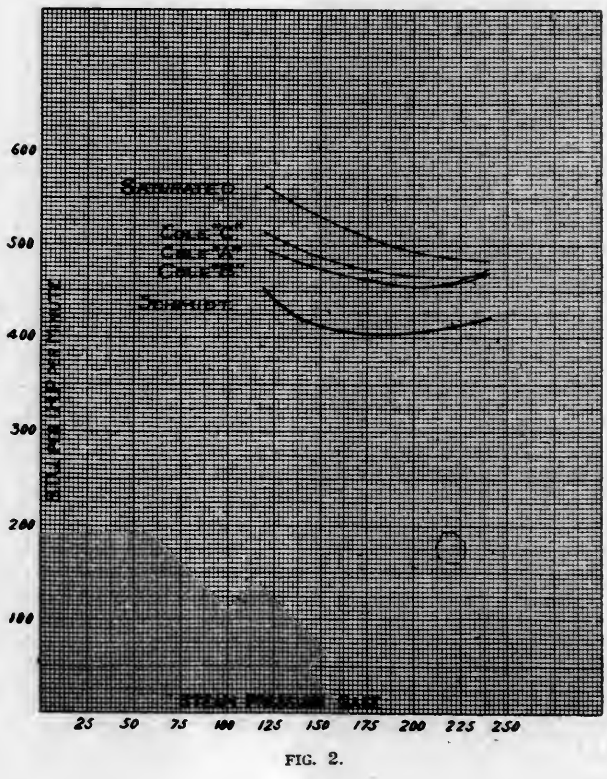


FIG. 2.

relation between the coal per indicated horse-power per hour and the degree of superheat for pressures of 160, 180 and 200 would seem to indicate, as brought out last year, that it could be represented by a curve as shown. In other words, the first 80 or 100 degrees of superheat does not make the same pro-

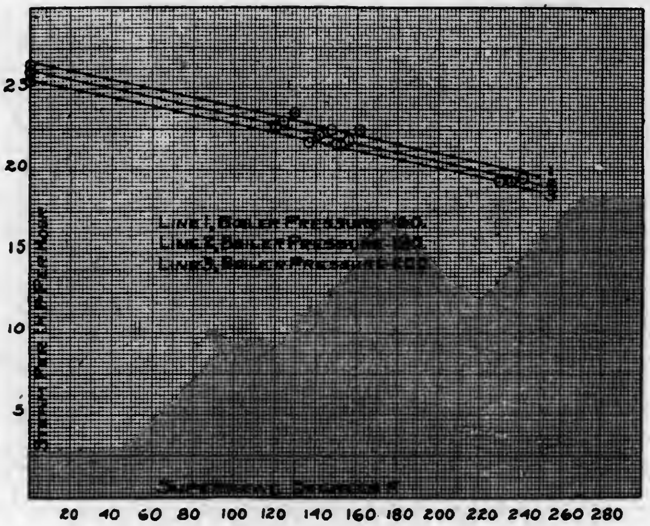


FIG. 4.

portionate decrease in coal consumption as does the second 80 or 100 degrees, and, in like manner, the third 80 degrees increase makes a still greater reduction in the coal consumption. For instance, the coal consumption per indicated horsepower per hour at 180 pounds steam pressure for the locomotive using saturated steam was 3.50 pounds, and for 80 degrees of superheat it was 3.4 pounds, a gain in efficiency of 2.8 per cent.; while the consumption at 160 degrees superheat is 3.05 pounds, a gain of 12.8 per cent., and the coal consumption at 240 degrees superheat is only 2.47 pounds, a saving of 29.4 per cent. over that of the locomotive using saturated steam. Thus, if we take the locomotive using saturated steam as consuming 100 per cent. of coal, it might be said that the first 80 degrees superheat will reduce this 2.8 per cent., the second 80 degrees 10.0 per cent., and the third 80 degrees, 16.6 per cent., making the total reduction for 240 degrees superheat, at 180 pounds pressure, 29.4 per cent. Practically the same results would be obtained for the curves representing 160 and 200 pounds steam pressure.

Conclusions.

a. A locomotive equipped with a superheater giving from 200 to 240 degrees of superheat will, during the time of running, effect a saving in coal consumption of from twenty to thirty per cent. over that of the same locomotive using saturated steam.

b. It would seem that the total gain in efficiency which could be obtained from superheat in a locomotive would not be reached until the temperature became too high for practical purposes.

Discussion.—Prof. Arthur Wood (Penn. State), on being given the privilege of the floor, raised a question as to the fairness of comparing the first 80 degrees superheat with the second 80 degrees, because of the probable presence of an indeterminate amount of saturated steam in the cylinders. He also asked for information on the probable location of the point of net economy when interest, depreciation, etc., of the apparatus is considered. This point in stationary practice is in the neighborhood of 100 degrees superheat, and for locomotives he thought that it would probably be below 270 degrees.

H. H. Vaughan (C. P. R.) stated that this paper explained clearly the causes of results he had reported at previous conventions, but was unable to explain. This referred particularly to his stand on the comparative uselessness of using low degree superheat. He had always placed the low limit at 160 degrees, but in view of recent results now believed that that figure was too low. He drew particular attention to the curves, showing the increased economy when the locomotive was working the hardest. While savings of 15 to 20 per cent. might be shown for a whole trip, when the locomotive was working hardest the saving or increased capacity was much more than this.

H. T. Bentley (C. & N. W.) reported entire success with superheaters on his road. The results of such tests as had been made checked those given in the paper very closely. The superheater engines were very popular with the crews, dispatchers and operating officials. Some trouble was at first given with lubrication, but the substitution of a single large lubricator on the right side of the cab for the two, one right and one left, had corrected it.

C. D. Young (Penn.) asked for information concerning the probability of getting equal economy with the combination of lower superheat and higher steam pressure, as was indicated by the curves given in the paper.

J. F. DeVoy (C. M. & St. P.) reported comparative tests with a superheater engine which checked the results given in the paper very closely. He was most favorably impressed with the work of the superheater in every way, and believed that a saving of 25 per cent. could be expected as a general proposition by its application.

Professor Endsley in closing the discussion stated that the low boiler pressure tests referred to by Mr. Young took into consideration other factors besides economy. No attempts had been made this year to find out concerning the increased power due to superheat. That feature would be next year's program. In reply to Professor Wood, he said that figures were not obtainable at present to show the point of net economy.

REPAIR EQUIPMENT FOR ENGINE HOUSES

Committee:—C. H. Quereau, Chairman; W. H. Fetner, H. P. Meredith, A. G. Trumbull, J. A. Carney.

We realize that no one solution will fit all conditions and that each engine house should have special study. At the same time, we believe there are a few general principles which should be kept in mind in the design, personnel, equipment and management of all engine houses.

It seems axiomatic that locomotives should be worn out in legitimate service as soon as possible. The capital invested in a locomotive represents a certain total of earning capacity, and the sooner this total earning capacity is realized the greater will be the yearly returns on the capital invested. In other words, a locomotive should be in service, earning as large a percentage of the time, and in the engine house or shop spending as small a percentage of time and money, as possible.

It also seems self-evident that the greater the efficiency of a locomotive, both in hauling capacity and fuel consumption, the greater the earning of the capital invested in it.

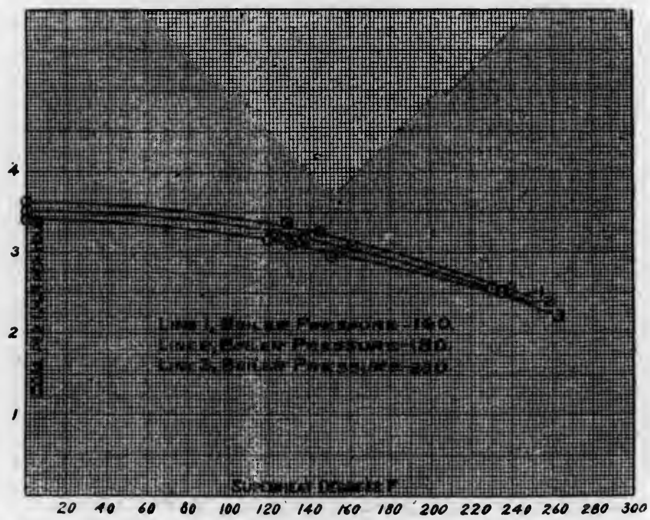


FIG. 5.

If it is a sound business proposition to wear out locomotives in service in as short a time as this can be done legitimately and to keep them as near one hundred per cent. efficiency as possible, these principles should be kept in mind in determining the extent to which repairs should be made at engine-houses, and this policy, once settled, in turn largely determines the repair equipment needed. In this connection we should not overlook the fact that any repairs made at engine-houses, more than light running repairs, increase the main shop capacity to a corresponding extent.

In order to obtain an approximate estimate of the net daily

earnings of a freight locomotive, the following calculations have been made. The gross freight earnings of a trunk line for the year 1910 were divided by 365 to get the average daily gross freight earnings. This result was divided by the total number of freight engines owned, plus nine-tenths of the switch engines owned. It was assumed the operating ratio for freight service was 60 per cent., leaving 40 per cent. net operating income. The result was that $45 was found to be the approximate daily net operating income from each locomotive engaged in freight service. This computation assumes each freight locomotive was in service every day. This means that we could afford to invest $900 capital at 5 per cent. in engine-house repair equipment for each extra day in service we could obtain for each freight engine owned, by making the repairs at the engine-house instead of at the main shop. Expressed more concretely, it means that, if the engine-house repair equipment kept each of 100 freight engines in service two extra days a year, the extra net operating income would be 5 per cent. on a capital of $180,000. This does not necessarily mean an increased net operating income, as it may, and in the end probably would, mean a smaller capital invested in freight locomotives.

While the fixed charges at main repair shops do not appear in reports showing the cost of locomotive repairs, it is evident they enter into costs and should therefore not be ignored. With a view to determining approximately the importance of this item, the figures for a shop at which no car repairs are made, repairing about 600 engines during 1910, have been taken. The average cost of repairs per engine, including labor and material, was found to be about $1,200, so there must have been a considerable proportion of the engines which received only medium and light repairs. This plant, including land, buildings, machinery and tracks, has a book value of about $1,000,000. Assuming that 10 per cent. of this value represents the fixed charges, these amount to $100,000 a year, or slightly less than $170 per year per engine receiving repairs at that point. It is interesting to note that the fixed charges amount to between 15 and 20 per cent. of the total amount charged at this shop to engine repairs for 1910.

The cost of fixed charges for another shop, at which, with the exception of some miscellaneous work, only locomotives are repaired, amount to $234.94 per year for each engine repaired, and are 13.2 per cent. of the total value of the plant.

In all probability it will be conceded it would be a waste of time and money to run a locomotive to the main shop to have a driving-box cellar repacked or the flues cleaned. Why? Because it would involve time lost from revenue service getting the engine to, through and from the shop, reducing the yearly earnings of the engine; necessitate the use of main shop space, increasing the capital invested in shops, or reducing the main shop output; congest the shop-track movements and disarrange the shop routine, thus delaying other more important shop work. At the main shop, though the item does not appear in the statistics showing the cost of repairs, there are the shop fixed charges, including interest on the investment, repairs, taxes and insurance, a no inconsiderable item. At the engine-house the fixed charges would be very much less, as they would not include those of the engine-house proper, the tracks, turntables, ash pits, coal chutes and other facilities necessarily provided, and would cover only the comparatively small investment in the shop building and machinery provided for repair work.

There can be little room for doubt that when there is a great demand for motive power, engine-house foremen and master mechanics, rather than send engines to the main shop, though this is near at hand, will take chances, resulting in breakdowns and delays; which would not be taken if they had repair equipment of their own. In other words, with tools and men under their immediate control and responsible for results, engine-house men will, in all probability, keep the motive power in better condition, more efficient and less liable to breakdown, and take a greater pride in making repairs quickly than when repairs must be made by an independent organization.

It is, we believe, common experience that the qualifications of engine-house employees should be quite different from those of repair-shop men. The work of the repair-shop man is steady and should be accurate, thorough and first-class in every respect, with the aim that a locomotive shall remain out of the repair shop as long as possible, and there is no pressing necessity that his job be finished by a certain minute. In contrast to this, the work of the engine-house man is spasmodic; at certain hours he is extremely busy, working under high pressure, and again has little to do. His chief care is to have the engines ready for their next run and in such condition that they will make at least a round trip sucessfully. If he accomplishes this, he is not criticised if his work is not exactly to blue-print or standard and rather coarse. His training makes him fertile in make-shifts to "get the engines over the road" without a breakdown or delay, which the shop man would, and should, refuse to countenance.

Probably because of this difference in ideals, viewpoint and methods of the shop man and engine-house man, when an engine goes to the main shop from the engine-house to have a certain part repaired it usually happens that a considerable amount of other work is done which would not have been done at the engine-house and could just as well have waited till a general overhauling was needed. In other words, when repairs, other than general, are made at the main shop, more work is usually done than is necessary. It is very likely the further fact that the shop man's experience is not such as to educate his judgment as to what work he can with safety let go, prompts and impels him to do more than necessary. Whatever the cause, there can be little doubt as to the fact. To those lacking the experience, it no doubt seems that this practice could be stopped by the issue of proper instructions and supervision, but proper instructions do not change human nature or lifelong habits, nor does a reasonable amount of supervision seem to work the miracle.

It is commonly the case at engine-houses that tools are frequently missing or inefficient for lack of repairs, resulting in considerable useless expense not only for tools, but in time lost in hunting them and exasperating delays in making repairs. We believe the remedy for this is a tool room, with some one in charge whose duties should include not only the issuing of tools on checks, but as well keeping the tools in good condition and a proper supply on hand.

If a locomotive must lay in the engine-house a day for lack of the material necessary to repair it, there follows a loss of earning power which, if expressed in dollars, would pay a good interest on a considerable investment in storeroom stock. It requires no labored argument to convince a motive-power official that a storeroom in connection with an engine-house is an essential, but not all of them appreciate its relation to the earning power of the equipment for which they are responsible. It is the opinion of the committee that a reasonable business basis on which to determine the most economical amount of stock to carry at engine-houses, assuming, of course, that stock carried is only that needed for engine-house repairs, is its effect in increasing the earnings of the locomotives.

We believe there should be kept at all important engine-houses an ample supply of spare parts, such as air pumps, lubricators, injectors and bell ringers, which should be used to replace defective apparatus whenever it will take less time to exchange than to repair, and as a general proposition, that important repairs to such accessories can be made to the best advantage at the main shops, where special tools and machinist specialists are available. It seems evident that the interest on the investment in spare parts must be less than the loss in earnings resulting from not having them.

The conditions under which engine-house work is of necessity done are much dirtier and more inconvenient than in the repair shop, and the rates of pay usually not so attractive. It follows that to get and keep a desirable class of men, engine-house conditions should be made as attractive and convenient for them personally as possible, including good ventilation and heat, lockers, toilet and washroom accommodations kept in first-class condition. It seems to us particularly important to have a system of ventilation which will quickly and thoroughly carry off the steam and smoke, which are necessary in an engine-house, that work may be done more rapidly and efficiently than would otherwise be the case.

It is not an unusual policy in equipping important engine-houses to use worn-out and obsolete tools. We believe this is short-sighted, not only because a big shop is better able to find profitable use for such tools and better able to keep them in repair, but engine-house conditions warrant the best of tools. If a tool is not efficient enough for repair-shop work it will generally pay to scrap it.

We should, therefore, when studying the requirements of round-houses, determining the kind of work to prepare for and the repair equipment needed, have in mind the following points:

Locomotives should be held out of service for repairs as short a time as possible.

Should be kept as near 100 per cent. efficiency as possible.

The effect on earnings of time saved by repairs made at engine-houses.

The effect on engine efficiency of repairs made at engine-houses.

The smaller fixed charges for repairs made at the engine-house, compared with those at the main shop.

The effect of storeroom stocks on engine earnings.

Engine-house men should have ideals and methods quite different from those of shop men.

It is important that engine-house conditions and facilities should be attractive and convenient to get and keep good men and increase their efficiency.

These conclusions can be generalized in the statement that locomotive repairs and repair facilities at engine-houses are warranted when they will result in increased earnings either because of more or better engine service obtained from a given number of locomotives.

APPENDIX.

Engine-houses may conveniently be classified under three heads: Those at minor division terminals, or the outlying ends of branch lines, where only very light repairs are made; those at important division terminals, and not in connection with important repair shops, and those in connection with repair shops.

At outlying engine-houses we assume there would be no power-driven machines and suggest the following list of tools, the number and sizes to be determined by local requirements:

Twist drills.	Pipe cutters.
Drill sockets.	Jacks, sledges, drifts, crow-bars, saws, brace and bits.
Taps — including machinists', steam-chest, pipe, wash-out, straight and taper, stay bolt.	Twist drills, extra long.
Dies to correspond.	Drill chucks.
Pipe stock and dies.	Ratchets and braces.
Hacksaws.	Surfacer plates.
Straight edge.	Tinners' bench shears.
Flue tools—caulking, rolls, expanders, beading.	Reamers, rod and taper.
	Wrenches, socket, crowfoot, hexagon.

In considering equipment for engine-houses at important division terminals not connected with repair shops, it is assumed there will be no dissent to the opinion these should be equipped with all such tools and appliances as will expedite the movement of locomotives through the house and keep them in first-class repair as far as this can be done without a backshop overhauling. It will take but little thought to convince the inquirer that the returns on capital wisely invested in such tools will make big returns when the resulting increased earnings of the capital invested in locomotives is considered, not only because of the time otherwise lost in going to, through and from the main shop, but, as well, the fact that locomotives sent to the main shop for specific repairs almost invariably receive more than these, the additional repairs not postponing the date of the final shopping and being almost inevitably made because of the training and point of view of the repair-shop forces—men and foremen—as mentioned in a preceding paragrah. Nor should it be forgotten that engine-house repairs will reduce the delays due to breakdowns and increase engine efficiency.

As local conditions vary and as conditions should largely determine facilities, it follows that the committee's recommendations can be only general. With this understanding, we submit the following suggestions. In general, we believe an engine-house should be equipped with driving and truck wheel drop pits and tools to take care of all necessary rod work, driving-boxes, ordinary valve-gear work and the replacing of flues needed between general overhaulings. In most cases it will be found that work of the nature indicated above can be done with but a very small addition to the engine-house force, because of the fact that, without this work, the men are, from the nature of the conditions, idle an appreciable part of the time. In line with this, some roads have found it economical to have always at the engine-house for general repairs an engine not needing heavy boiler work.

The list of tools suggested for outlying engine-houses, to be expanded to meet the requirements of a larger terminal:

Ample storeroom stock.	Hot-water washout facilities.
Drop pit for driving-wheels.	Drop pit for engine truck and tender wheels.
Double blacksmith forge, face plate and tools.	Portable blacksmith forges.
72-inch boring mill.	36-inch boring mill.
Driving-wheel lathe.	24-inch lathe.
38-inch tire turning lathe.	16-inch lathe.
Planer.	Shaper.
Slotter.	36-inch vertical drill.
Sensitive drill.	Emery grinder.
Bolt cutter.	Pipe-bending machine.
50-ton hydraulic press.	Punch and shear.
Power-driven valve-setting machine.	Air compressor.
Air hammers.	Air motors.

For engine-houses in connection with repair shops, the committee has not been able to agree. Several of the members feel that it is economical to depend on the main shop for considerable machine work. On the other hand, the other members believe that, except for tire turning, the equipment should be practically the same as for an independent engine-house, because of the saving of time and cost of repairs and the different training of engine-house and shop men.

Discussion.—It was the general opinion among those who discussed this paper that too much importance cannot possibly be associated with the question of providing the very best facilities, both in buildings and equipment.

F. F. Gaines (C. of Ga.) believes that in a large terminal the roundhouse should be entirely separated from the back shop, and with all necessary equipment to take care of the running repairs without having to depend on the back shop. He differed from the report in one respect, that it did not recommend any tool equipment at outlying points. Mr. Gaines thinks that wherever it is possible a drill press, lathe and a few other tools should be installed, and mentioned that electric power is generally available at outlying points through the city's lighting system.

C. E. Chambers (C. of N. J.) agreed with the committee on points of equipment of roundhouses, and when properly equipped considers it one of the best aids for proper back shop work. A. E. Manchester (C. M. & St. P.) and J. F. DeVoy (C. M. & St. P.) both agreed with the views entertained by the previous speakers and with the committee, that roundhouse men should be specialists.

R. D. Smith (B. & A.) believes that 60 per cent. of the maintenance of the locomotive should be expended in the engine house to insure the best road service, and 40 per cent. in the shop. He recommended the installation of drop pit sections made from 100 to 112 feet long, in order that an engine can be moved with the shop doors closed, to permit the dropping of any wheel.

E. W. Pratt (C. & N. W.) concurred with Mr. Smith in advocating the use of extra long drop pits, which is in line with the practice being followed on his road in later work. The fact that the modern freight terminal appears to have the consolidated engine in the majority, there are four pairs of tank wheels and one pair of engine truck wheels to be dropped. If the truck wheel pits have an extension permitting the movement of the engine any pair of tank wheels can be taken out, and the engine still kept inside the roundhouse walls in bad weather.

Mr. DeVoy (C. M. & St. P.) opposed the drop pit extensions in view of the expense for the necessary land in some cities, and expressed a preference for a wire rope engine haul operated by the turntable tractor.

In closing the discussion, Mr. Quereau said that it was not the intention of the committee to go into details, but simply to discuss the subject on its broad general grounds. The list of tools to be kept at a roundhouse was not intended as one that should be applied to all such plants, it being intended for use in roundhouses where there is no power. He is of the opinion that a road which does 60 per cent. of its repairs in the roundhouse and 40 per cent. at the back shop, will have its engines in better condition and at a less expense.

CONTOUR OF TIRES

Committee:—W. C. A. Henry, Chairman; O. C. Cromwell, J. A. Pilcher, O. M. Foster, A. C. Adams.

The Committee on the Contour of Tires has been instructed to give consideration to the following and make recommendations: The desirability of adopting the M. C. B. standard contour for engine-truck wheels, tender-truck wheels, driving and trailing wheels, also limit of wear of tread, shop and road limit of last turning, maximum height of flange, thickness of flange and gauges.

As the present standard contour for cast-iron wheels of the American Railway Master Mechanics' Association is identical with the 1909 standard of the Master Car Builders' Association, we are assuming that our instructions as to contour refer to steel and steel-tired wheels only.

Replies to our circular of inquiry indicate that the M. C. B. 1909 contour is being very generally used for engine-truck and tender-truck wheels. Some roads have already adopted this contour for flanged driving-wheel tires as well. We feel that this contour is desirable for all flanged wheels under locomotives and tenders for the same reason that it is desirable for car wheels, in addition to which is the feature of uniformity.

The present A. R. M. M. A. standards call for six widths of flanged tires, and five widths of plain tires, as follows:

Flanged tires....	5 in.	5¼ in.	5½ in.	5¾ in.	6 in.	6¼ in.
Plain tires......	6 in.	6¼ in.	6½ in.	6¾ in.	7 in.	

Replies from the manufacturers of steel tires indicate that of the flanged tires manufactured by them, there are practically but two widths, namely, 5½ inches and 5¾ inches, the large majority being the former. In the case of plain tires the prevailing widths manufactured are 6 inches, 6½ inches and 7 inches, there being little demand for the 6¼-inch and 6¾-inch widths. It is the opinion of the committee that one standard

for cast-iron and one for steel and steel-tired flanged wheels, namely, the M. C. B. 1909 standards, and three widths of the present A. R. M. M. A. contour for plain tires will meet all requirements and be to the advantage of all concerned, due to the fewer number of standards.

The prevailing limit of wear of tread or channeling for all wheels under locomotives and tenders is 1/4 inch for locomotives in road service and 5/16 inch for locomotives in shifting service, which we feel is good practice.

In investigating the subject of limits of wear of driving-wheel tires we have found the greatest variation. After full consideration, it does not seem possible, or advisable, to establish a minimum road limit to be followed by all roads. Where long, steep grades necessitate heavy braking, or severe weather conditions result in frozen roadbed for long periods of time, tires cannot be worn to the same degree of thinness as where these conditions do not prevail. Also, the use of retaining rings, which practice, however, is not universal, has a bearing on tire thickness. After consideration of all the data available, we feel that the limits prescribed on the chart submitted as a portion of our recommendations will be suitable for roads not having severe grades, or extremely cold weather, and not using retaining rings. Where these conditions prevail, or retaining devices are used, such deviations will have to be made as experience indicates are desirable.

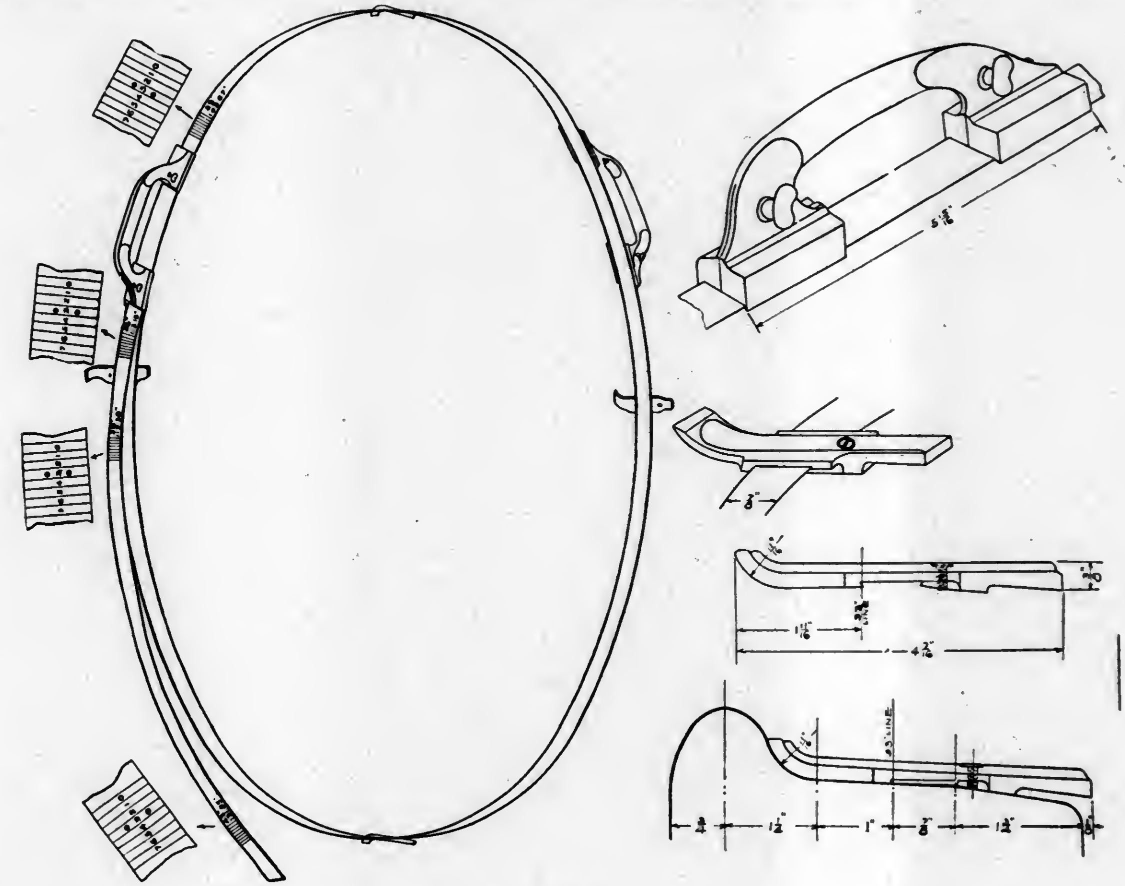
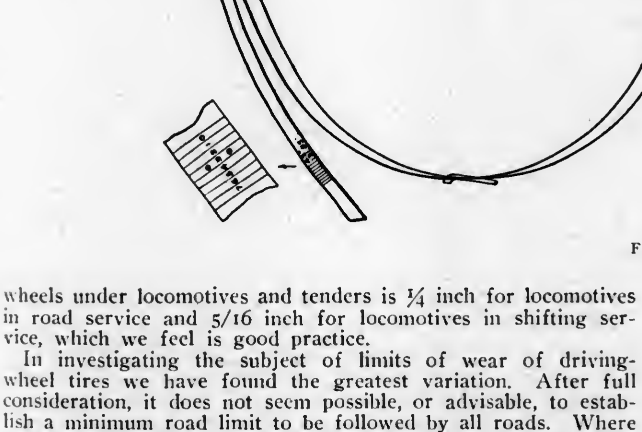


FIG. 1.

ROAD LIMITS OF TIRE WEAR FOR DRIVING AND TRAILING WHEELS
VARIOUS CLASSES OF SERVICE - HELD BY SHRINKAGE ONLY.



The prevailing practice is to establish the shop limit of thickness of tires 1/4 inch above the road limit. This limit is strictly one of economy and not safety, and will vary with the facilities for doing the work. We, therefore, hesitate to recommend a definite shop limit.

The M. C. B. limit for thickness of tire or rim for steel and steel-tired wheels is being generally followed in the case of engine truck and tender truck wheels with satisfactory results, and the committee recommends the same limits be adopted.

The M. C. B. Association has already adopted a maximum height for flanges, of 1½ inches. This was considered the maximum height flange that would not, in service, damage track bolts, filler blocks, etc. There is no reason why this maximum height should be deviated from.

The question of gauges is one in which there is practically no uniformity, each road apparently having gotten up a gauge to suit its individual views. We are submitting recommendations for a shop or roundhouse gauge on which can be read direct the important dimensions; namely, channeling of tire, height of flange, and thickness of tire.*

It has been suggested that the number of brackets on standard wheel circumference measure be increased from three to four and the length of the brackets increased so as to project 1/8 inch beyond the rim when brackets are in proper position. The present method of graduating the circumference measure does not provide a definite boundary for each tape size, as the tape sizes are indicated by lines.

It is, therefore, recommended that instead of defining tape sizes by lines they be defined by spaces. The committee is of the opinion that these changes in the size and number of brackets, as well as the markings of the circumference measure, all of which are shown on Fig. 1, are desirable.

RECOMMENDATIONS.

We recommend the M. C. B. 1909 contour for all flanged steel or steel-tired wheels, as follows:

(a) Engine truck.
(b) Tender truck.

* Illustration not reproduced because of blurred condition.

(c) Driving wheels.
(d) Trailing wheels.

Plain tires to be of three widths, namely, 6 inches, 6½ inches and 7 inches, the contour to be the same as the present standards; the widths of 6¼ inches and 6¾ inches to be eliminated.

Limit of wear of tread or channeling to be as follows: ¼ inch for all locomotive and tender wheels in road service; 5/16 inch for all locomotive and tender wheels in shifting service.

Road limit for driving and trailing wheels to be as specified in the chart.

Road limit for steel and steel-tired wheels for engine and tender trucks to be the 1909 recommended practice of the M. C. B. Association.

Maximum flange height to be 1½ inches.

Wheel circumference measure to be modified as per Fig. 1.

Discussion.—There was a very active discussion pro and con on the matter of the height of flange and the advisability of using the taper tread. Members reported in favor and against both practices to so great a number that the subject was finally disposed of by referring it back to the committee with instructions to investigate the subjects mentioned more fully and report next year.

LUBRICATION OF LOCOMOTIVE CYLINDERS

Committee:—C. H. Rae, Chairman; Jos Chidley, T. R. Cook, J. F. DeVoy, J. F. Walsh, S. T. Park, P. M. Hammett.

A number of questions were submitted to members, the replies to which contained the following information:

There is no serious difficulty now experienced in lubricating modern passenger and freight locomotives with the "up-to-date" lubricators of the hydrostatic-feed type.

Several of the members referred to a recent improvement in the hydrostatic lubricator, whereby it is made possible to close or shut off feeds without interference with the feed-valve adjustments. This is an economical feature, but of such recent date that no comparative data have been submitted as to the results obtained. One member replies in regard to devices which increase the efficiency of hydrostatic lubricators as follows: "The automatic steam-chest choke plugs, which feed against a constant boiler pressure in the oil pipe, and not against a pressure that fluctuates with pressure in steam chest, will result in a high degree of efficiency in the lubricator."

The replies to questions concerning mechanically operated lubricators were limited in number. Following are quotations from several:

"Have used several types of mechanically operated forced-feed lubricators. Three of those experimented with were driven from a moving part of the engine. This was unsatisfactory, since the feed is required that does not vary with the speed of the engine. More oil is required per minute while the engine is worked hard at low speeds than when running fast with light throttle. To overcome this we used some forced-feed lubricators with independent air motor. None of them, however, have been satisfactory. It is difficult to apply to the filling holes screens that are fine enough to keep out dirt, without restricing he speed at which the oil can be put in, and the enginemen pull them out. The consequence is that the plungers wear rapidly, and after a time the feed becomes irregular. They are troublesome to maintain, and under conditions specified, in answer to question No. 1, gave no better results than the hydrostatic lubricator.

"We have experimented with two or three makes of mechanical-feed lubricators, but have been unsuccessful in getting as good results as we do with the hydrostatic-feed lubricators. The trouble with the mechanical-feed lubricator seems to be due to the difference in temperature; in warm weather, or during the warm part of the day, they would feed sufficient oil, but in cold weather, or at night when the weather is colder, they do not feed as well as when it is warmer."

"We have used two mechanical lubricating devices, which received their motion from a connection made to the valve stem and oil chamber, and regulating devices were located in the cab. Our test record shows that after considerable experimenting the device operated fairly well, but after a time gave considerable trouble and was finally removed on account of not giving satisfactory results. Mechanical means are objectionable, in that the device is so complex, and consists of so many parts, it is difficult to keep joints from leaking. To be properly installed, all pipes must be kept constantly filled and under pressure, with return valves at distributing points. On account of mechanical movements, parts will wear, and it will be more expensive to maintain, and in making repairs more oil is lost than with hydrostatic lubricators. Devices of this sort do not appear to have as yet been perfected to such an extent as to make them thoroughly reliable."

"Have used a force-feed lubricator with pipe connections to all driving boxes and to steam chest. Operated by mechanism deriving its motion from connection to Walschaert link. Lubricator located in the cab.

"While reducing friction on journal bearings, and delivering oil to steam chest, I do not consider it entirely satisfactory, for the reason that there is nothing to indicate that the pumps are working properly and delivering the oil until the valves become dry."

"Our objections to mechanically operated lubricators is that they are necessarily more complicated than the hydrostatic lubricator, without showing any beneficial results."

"Have tried some, but have not obtained satisfactory results."

"We have in the past used on some of our two-cylinder compound engines mechanically operated lubricators. Our objection to it was the rapid wear of the parts, leakages and annoyances."

"Using displacement plunger force feed. Secured in suitable location in cab, and operated by a series of rods and bell cranks, which are connected, either to eccentric blades and independent eccentric on rear, or other convenient axle, or by reducing-arm on back crank pin. Device subject to varying control, and fed by increasing or decreasing stroke of plungers by means of adjustment thumb-nut.

"Results as to economy and distribution very satisfactory. Slight trouble experienced in experimental stage, due to method of operating lubricator."

In reply to questions concerning experience with admitting oil into the steam before it reaches the steam chest, the following information was given:

"Present method in use with mechanically operated lubricator is to tap direct through dome into steam pipe, or throttle box. This method has proven to be superior to the old method of admitting to steam chest direct."

In this connection, a member refers to a test:

"Delivering the oil from the right side of the lubricator into the left cylinder, passing it through the smoke box, and from the left side of lubricator into the right cylinder in the same manner.

"The gases in the front end superheating the oil, and evaporating the water of condensation, putting the oil into the cylinders superheated."

Questions Nos. 9 and 10, in reference to superheater locomotion, have been considered jointly by the members. In the information submitted, the important features of this phase of the subject are well expressed in the following quotations:

"Superheat varies from 550 to 580 degrees. Our regular practice is to use one feed pipe to valve chest, applying it to go to each end of valve in center of the valve bushing. This lubricates valve very well, but it is questionable whether delivering oil to steam passage is not preferable. We also use one feed to each side of cylinder, at top in center. This is not used unless required. When working with full throttle and long cut-offs, over considerable distances, find cylinder feed necessary.

"There is no difficulty whatever in obtaining satisfactory lubrication in superheater engines with hydrostatic lubricators, on account of difference of pressure between steam chest and boiler, previously mentioned. In fact, there is considerably less difficulty than on engines using saturated steam. In spite of this the piston-ring wear is far more rapid."

"On our superheaters we carry 170 pounds boiler pressure; the maximum degree of superheat is 225. On a number of superheater engines we introduced oil both at the steam cavity and into the cylinder direct; found the latter connection unnecessary.

"The only trouble which we had with superheater engines was to get our men to use the drifting valve when the engine was shut off. If this is not done, have experienced trouble with the bushings cutting out, but on districts where the drifting valve is put on we are having very good success."

All replies to the question concerning lubrication of Mallets pertain to the satisfactory use of the hydrostatic lubricator. No information furnished concerning use of mechanically operated lubricators on Mallet compound locomotives using superheat.

Replies to question No. 12 were at variance as to the location of the oil pipes, but it was the consensus of opinion that piping to the high-pressure valves and cylinders only was insufficient for satisfactory lubrication of Mallets.

The experience of the committee, supplemented by the information received from the members of the Association, warrants the assertion that there is no serious difficulty now experienced with the use of the hydrostatic-feed lubricator.

The recent addition of a stop-feed feature is an improvement, rather tending to economical operation than to efficiency, and it behooves the manufacturers of this device to keep pace with, or in advance of, the constantly increasing demands.

The information obtained from the members, and cited in the foregoing, confirms the experience and opinion of the committee, that a properly constructed hydrostatic lubricator meets the locomotive requirements better than a mechanically operated lubricator, for the several reasons:

(1) Familiarity with care and operation by the different classes of labor whose duties are in connection with its use.

(2) Simplicity of design and substantial in construction; the operating parts being better protected from disarrangement or breakage.

(3) A more accurate regulation of the amount of oil applied to the valves and cylinders under the varying conditions of service performed by the locomotive at different speeds and points of cut-off.

(4) Because of less complication in construction and attachments, a corresponding less expense of maintenance.

The more general custom of delivering the oil to the steam chest or valve chamber is open to question, and there has been some very conclusive evidence submitted favoring the delivery of the oil into the steam at a point where it may become highly attenuated and intermingled with the steam.

The presumed effect of extreme temperatures, due to high pressure and superheat upon the oil, has been an objection to delivering the oil in the steam before it reaches the cylinder saddle. Information has been furnished and confirmed by the experience of some of the members, that the efficiency of a properly compounded mineral cylinder oil is not seriously impaired when protected by the steam.

As the reports on this particular feature of the subject are indefinite, the committee recommends further consideration and experimentation.

The information obtained from the members who have had the most general and extended experience with locomotives using superheated steam confirms the experience and opinion of the committee, i. e., that the same reasons advanced for the endorsement of the hydrostatic-feed lubricator on locomotives using saturated steam apply to locomotives using superheated steam.

The information submitted and quoted in the replies, pertaining to the proper location and number of oil pipes on superheated locomotives, is of much value. The experience thus far is not sufficiently conclusive to justify a decisive recommendation at this time.

We would, however, particularly recommend that liberal openings be given to drifting valves, and attention to their proper manipulation, that the temperature of the cylinders may be promptly reduced within the lubricating possibilities of the oil when exposed to the atmosphere.

The problem of satisfactorily lubricating the Mallet compound locomotive is still in process of solution. At present it seems essential to pipe independently to the high and low pressure cylinders. However, the committee has been advised that there has been some experience, with satisfactory results, by eliminating the pipes to the low-pressure valves and cylinder, substituting an auxiliary oil pipe to the receiver with the high-pressure steam connection. This carries sufficient oil over to the low-pressure cylinders to insure good service.

Increased efficiency and reduced expense of operation confronts the mechanical departments of our railways to a greater extent than ever before.

Discussion.—There was practically no discussion accorded this paper. George L. Fowler said that the Long Island Railroad has been experimenting for the last six or eight months with a mechanical lubricator for cylinders in wich a mixture of oil and graphite is pumped into the cylinder, operated mechanically, and after a run of about two hundred miles the faces of the steam chests, valves and cylinders become coated with the film of graphite, and the operation has been found very successful and satisfactory.

E. A. Miller (N. Y. C. & St. L.) finds that very good results can be obtained by applying the graphite at the commencement of each trip to a cup, separate from the lubricator, and applying this graphite cup to the steam chests in addition to the regular lubricator.

George A. Hancock (St. L. & S. F.) said that his road had 50 engines with the steam temperature about 535 to 565 degrees, and that the mechanically operated lubricator had proved unsatisfactory. Instead of admitting oil directly through the cylinder and valve, Mr. Hancock said that the practice now being followed on the 'Frisco is to connect the oil pipes direct to the steam passage. This in connection with a small amount of graphite gives satisfactory service. He added that the oil allowance was one pint of valve oil for every forty miles on freight service, and one pint for every sixty miles on passenger service.

CONSOLIDATION

D. F. Crawford, chairman, reported that the committee had investigated and found there were no legal reasons to prevent the consolidation of the two associations. The motion of H. T. Bentley that the committee be continued was carried.

REPORT OF COMMITTEE ON MAIN AND SIDE RODS

Committee:—W. F. Keisel, Jr., chairman; H. Bartlett, G. Lanza, H. B. Hunt, W. E. Dunham.

The following is submitted as a progress report, with the request that every member of the Association send the committee criticisms or suggestions for modifications before February 1, 1912. The data already furnished by the members form a very interesting study. The first part of the subject relates to kind of material in rods. There is very little difference in the steel for rods, and open-hearth steel having an ultimate tensile strength of 80,000 pounds per square inch is used by all railroads. There is some variation in the chemistry. Special alloy and heat-treated steels have been considered and put in service, but, to date, information relating to such steels in rods is too meager to justify recommending their use. The second part of the subject relates to specifying formulæ for checking up sizes and designs of main and side rods.

1. MAIN RODS.—The rod bodies are subject to the following strains:

First: Tension and compression, due to piston pressure and inertia of reciprocating weights.

Second: Bending, caused by centrifugal force acting vertically.

Stresses from compression are always more than from tension.

Reciprocating parts are made as light as possible, and stresses due to inertia of reciprocating weights are usually less than those created by cylinder pressure. Furthermore, when drifting, the amount of retardation, due to vacuum and compression in the cylinder, will, to some extent, balance the inertia strains. If for passenger and high-speed freight locomotives the maximum piston pressure is less than the product of the reciprocating weights by four times the crank length in inches ($P < 4rW$) the latter value ($4rW$) should be used in place of maximum piston pressure. For slow freight and shifting engines, such substitution is not necessary. From the above it will be noted that the calculations may be confined to a consideration of rod body as a strut, with load equal to the piston pressure, or its substitute, and as a beam subject to bending on account of whip action at high speeds.

2. SIDE RODS.—The rod bodies are subject, first, to tension or compression arising either from a part of the piston pressure transferred through main crank pin, or from a requirement for the rod to slide one or more of the driving wheels, and second, to bending caused by centrifugal force acting vertically. When all drivers are not of exactly the same diameter, and when the locomotive is passing over curves, the side rods must slide drivers. The limit of the force to slide drivers is governed by the coefficient of friction between wheels and rail. The commonly accepted coefficient of friction when calculating tractive power, is .25, or less. For our purpose it should be somewhat higher, to be on the safe side. A number of builders and roads use the coefficient .3, which fully meets the requirements.

For starting, we assume that each rod must be capable of sliding the *pairs* of drivers to which it imparts rotation, but when running at speed it must slide the drivers on one side only. Therefore, the value P in Professor Lanza's formula would be

$$P = \frac{WR}{r} \text{ for starting.}$$

$$P = \frac{WR}{2r} \text{ for running at speed, in which}$$

W=Weight on pairs of drivers receiving rotation from the rod.

R=Radius of wheel.

r=Radius of crank.

As stated at the beginning, most roads base calculations of rods on a speed of 336 revolutions per minute. This is high for some engines, such as Mallet compounds, and low for fast passenger engines, some of which now reach a greater speed, and the tendency is to achieve still greater speed. The use of 375 revolutions per minute, for fast freight engines and passenger engines, and 420 revolutions per minute for fast passenger engines would be sufficiently high for ordinary locomotives. For Mallet compounds, and other very slow locomotives, a special figure may be taken.

3. RODS AS STRUTS.—Main rods are almost invariably made taper, and the section, if fluted, may vary in thickness of flange, height of web, thickness of web, or a combination of two, or all three. The taper is never of such amount that the results are appreciably affected if calculations are based on the section at the center, the same as for rods having a uniform cross-section. Good practice indicates that this center area for all rods should not be less than maximum assumed end load divided by 10,000 pounds. Merriman's Rational Formula for columns (see Kent's Pocket Book) is:

$$C = \frac{B}{1 - \frac{nB}{\pi^2 E} \frac{L^2}{r^2}} \text{ in which}$$

B=Unit load.
C=Maximum compression unit stress.
L=Length of column.
r=Least radius of gyration.
E=Coefficient of elasticity.
n=1 for both ends, round.
n=¼ for both ends, fixed or flat.

If we have a unit stress of 10,000 pounds per square inch, the value of length divided by least radius of gyration (L÷r) must not exceed eighty (80) for neutral axis vertical or parallel with side of rod, and not more than one hundred and sixty (160) for neutral axis horizontal. For these values the maximum compression unit stress is 12,710 pounds per square inch, or slightly within the assumed figure for maximum allowable stress of one-sixth of the ultimate tensile strength.

With neutral axis vertical for rods having rectangular section $r = b \sqrt{12}$ ("b" being the depth of section). Substituting this in L÷r=80, we get L=23b. Therefore, if the length from center to center of pin is less than twenty-three (23) times the depth of a rectangular rod, the value L÷r is less than 80. Similarly with neutral axis horizontal $r = a \div \sqrt{12}$ ("a" being width of rod) and the value L ÷ r is less than one hundred and sixty (160) when L is less than forty-six (46) times the width of section.

4. Offset Rods.—A number of the rods are offset, that is, the vertical center line of the bearings at the end do not lie in the same plane, or in the plane of the center line of rod body. The greatest offset given is 1 13-16 inches. This creates a bending strain and increases the stress in the rod body. The added stress from this source is equal to the product of the maximum end load and the offset, divided by the section modulus with axis vertical, and requires a correspondingly larger section modulus.

5. Side Rods with Knuckle Joints.—Rods for three and four coupled locomotives must be provided with knuckle joints. The knuckle joints are all necessarily flexible vertically, and some are flexible horizontally also. When the drivers on one side are not in perfect horizontal alignment, slight bending strains occur, in addition to the compression strains. To take these bending strains into consideration would complicate the formulæ. The end pressures on the rods being based on driver weight and a coefficient of friction greater than that expected, the margin in this assumption is sufficient to compensate for the bending strains arising from the non-alignment of the drivers on the one hand, and the deflection of the rod due to centrifugal force, when running at high speed, on the other hand; therefore, both bending strains may be ignored for the purpose of simplifying the final checking formulæ. When running at speed the centrifugal force from the short rod connected to the extension of the long rod reduces the bending strains due to centrifugal force in the long rod. As the extension to the long rod is short, this effect may also be ignored as the possible reduction in weight of long rod would not be appreciable. When the drivers, due to wear between hubs and boxes, etc., are not in vertical alignment, bending strains are induced. Knuckle joints are at times made flexible transversely, in addition to the vertical flexibility, for the purpose of eliminating the bending strains. For locomotives on which a large amount of side play is allowed to accumulate, this transverse flexibility is of great value, to avoid rod failures. When the knuckle joints are flexible in both directions, the value of L÷r, for the short rods, should be one hundred and ten (110), instead of one hundred and sixty (160), given in No. 3 (rods as struts).

6. Bending Strains Due to Whipping, at High Speed.—For main rods the point of maximum bending strain is always very close to six-tenths of the length from crosshead end. This statement is based on the examination of a large number of rod designs. The section at this point may, therefore, be taken as the governing section. For side rods the point of maximum strain is at the center.

7. Simplification of Formulæ.—As accurate calculations are rather lengthy, and must necessarily be based on conditions representing extremes, simple formulæ giving values within a very small per cent. of those obtained by the more accurate method are better adapted for the purpose and especially useful for checking. The basis for bending strains at speed is centrifugal force (F). If G represents the weight, considered in pounds, and r represents the crank radius, in inches, then

Centrifugal force	=	2Gr	3Gr	4Gr	5Gr for
Number of revolutions per minute		265	325	375	420

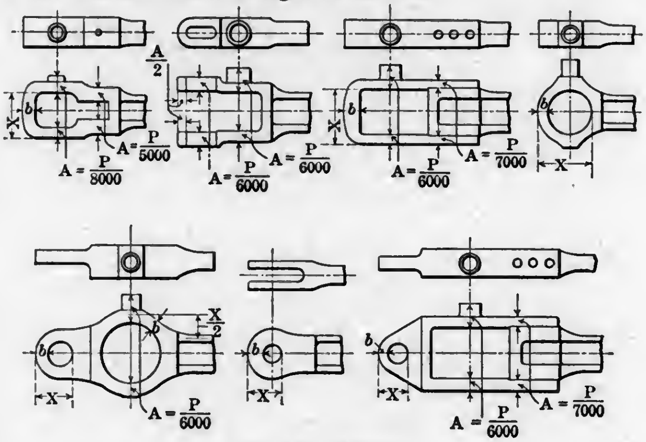
A cubic inch of steel weighs closely .2833 pounds. Both main and side rods may be considered as having a uniform section, equivalent to the governing section and extending from pin to pin. This assumption is accurate for side rods, but for main rods gives stresses at high speeds, possibly one per cent higher than those found by the accurate method.

If A=Governing area of rod, in square inches
and L=Rod length, center to center of pins, in inches,
then G=.2833 AL
and Gr=.2833 ALr.
For side rods the bending moment M=.125FL.

The formulæ for bending moment (M) for main rods and side rods, at the assumed speeds, are noted in the following tabulation:

Revolutions per minute	265	325	375	420
"M" for main rods.	$.036AL^2r$	$.055AL^2r$	$.073AL^2r$	$.091AL^2r$
"M" for side rods..	$.071AL^2r$	$.106AL^2r$	$.142AL^2r$	$.177AL^2r$

From the above, the stress due to whipping action may be found by means of the well-known formula, $M \div SM$=Stress, to which the stress due to end strains, assumed as maxima, must be added. The sum of these stresses should not exceed one-sixth of the ultimate tensile strength of the steel.



CHECKING FORMULAE.

All measurements are given in inches and pounds.
A = Area of section considered.
a = Width of section considered.
b = Depth of section considered.
C_1 = Max. compression unit stress for transverse bending.
C_2 = Max. compression unit stress for vertical bending.
c = c_1 — c = coefficients.
d = Cylinder diameter.
L = Length of rod from centre to centre of pins.
M = Bending moment.
P = Max. compression strain acting at end of rod.
p = Max. boiler pressure.
Q = Cylinder pressure = $0.7854\ d^2\ p$.
R = Radius of driving wheels.
r = Radius of crank.
RG = Radius of gyration of section — axis horizontal.
rg = Radius of gyration of section — axis vertical.
S = Stress — and where used in formulæ must not exceed one-sixth of ultimate strength of the steel.
s = Amount of horizontal offset in rod.
SM = Section modulus of section considered — axis horizontal.
sm = Section modulus of section considered — axis vertical.
W = Weight on pairs of drivers actuated through rod considered.
Main rod area must not be less than P ÷ 10,000 lbs.
For main rods P = Q.

For side rods $P = \frac{0.3\ WR}{r}$

To determine C_1 and C calculations should be based on a section half way between rod pins.

For transverse bending in rods having knuckle pins flexible transversely

$$C_1 = \frac{\frac{P}{A}}{1 - \frac{PL^2}{675{,}000{,}000\ A\ rg^2}}$$

For all other rods

$$C_1 = \frac{\frac{P}{A}}{1 - \frac{PL^2}{1{,}200{,}000{,}000\ A\ rg^2}}$$

For vertical bending in all rods

$$C_2 = \frac{\frac{P}{A}}{1 - \frac{PL^2}{300{,}000{,}000\ A\ RG^2}}$$

Values for C_1 and C_2 can also be taken from tables in "Kent's Pocket Book" under heading "Merriman's Rational Formula for Columns."

First—

For rods without offset the larger value of C_1 and C should be taken equal to S.

For rods with offset the larger value of $C + \frac{Ps}{sm}$ and C_2 should be

Second—

$$S = c\frac{AL^2r}{.SM} + c\ P\left(\frac{I}{A} + \frac{s}{sm}\right)$$

The calculations should be based on a section located at a distance 0.6 L from crosshead pin for main rods, and half way between pins for side rods.

VALUES OF C AND C

Rev. Per Min.		265	325	375	420
Main Rod	$C =$	0.036	0.055	0.073	0.091
	$C_1 =$	0.500	0.500	0.400	0.300
Side Rod	$C =$	0.071	0.106	0.142	0.177
	$C_1 =$	0.500	0.500	0.500	0.500

The coefficients selected should correspond with the highest number of revolutions per minute which the locomotive can make.

If this cannot be determined, use
420 R.P.M. for high speed passenger locomotives.
375 R.P.M. for passenger and high speed freight locomotives.
325 R.P.M. for all other locomotives.

Very simple rules for rods, without offset, and having bodies with rectangular section, based on the above theory, follow.

First—

Stress is less than one-sixth of ultimate strength of the steel if "L" is less than 46 "a" or 23 "b" and if "A" is more than "P" divided by one-eighth of ultimate strength of the steel.

Second—

$$S = C_2\frac{L^2\,r}{b} + C_1\frac{P}{A}$$

VALUES OF C_2 AND C_1

Rev. Per Min.		265	325	375	420
Main Rod	$C_2 =$	0.22	0.33	0.44	0.55
	$C_1 =$	0.50	0.50	0.40	0.30
Side Rod	$C_2 =$	0.43	0.64	0.85	1.06
	$C_1 =$	0.50	0.50	0.50	0.50

The allowable stresses for the various sections of rod ends are given in connection with the diagrams above, except where thickness of section is indicated by the letter "b." The figures denote maximum stress allowed under end load "P." If the minimum areas of the two members differ, take double the lesser area for "A."

The minimum area at points indicated by letter "b" should be—

For main rods— $$A = \frac{PX}{30{,}000\ b}$$

For side rods— $$A = \frac{PX}{60{,}000\ b}$$

In which "X" is the average diameter of eye or average spread of jaw members.

Discussion.—This report was most appreciatively received by the members, and much valuable experience followed in the discussion. The most interesting features of the latter were in regard to the relative merits, or immunity from breakage of I section and rectangular section rods, and the practicability of forging fluted rods.

In this latter connection F. F. Gaines (C. of Ga.) said that he is developing a scheme to remedy the difficulty suggested by H. T. Bentley (C. & N. W.) of being obliged to mill out the very best part of a new rod to obtain the channel. Mr. Gaines explained that he has a forging press, a very slow action hydraulic machine, which works the metal to the center and expected to obtain very satisfactory rods by its use.

J. A. McRae (M. C.) said that he had discarded I section rods for all low speed engines, such as those engaged in freight service, the practice being to smooth forge them. This accomplishes the purpose of not cutting out the good metal, and the speaker added that they have obtained very good results from rectangular forged rods.

President C. E. Fuller mentioned that the question of forged fluted rods is a very old one, it being done with light engines when he was connected with the Central Vermont Railroad in 1892. A large number of its engines were equipped with fluted rods, forged without any machinery other than the bush centers. The results were excellent, but whether they would carry out with the heavier type is a question, as the rod is now so much heavier and larger that it would make quite heavy forging.

D. R. MacBain (L. S. & M. S.) said that after considerable experience on the New York Central lines with the various types of rods, fluted and otherwise, the conclusion has been practically reached that for all slow speed engines the rectangular section is by far the best proposition.

R. Patterson (G. T.) stated that a great deal of trouble had been in evidence on his road with fluted rods breaking, and the rectangular rod was substituted. He is confident that the latter will give much better service.

Mr. Kiesel in closing the discussion requested the various members of the association to let the committee hear from them by Feb. 12, after they have had a chance to look the report over more thoroughly and compare it with their own practice, and to advise the committee, particularly whether they consider the stresses allowed in the report as checking stresses are too high.

DESIGN CONSTRUCTION AND INSPECTION OF LOCOMOTIVE BOILERS

Mr. Seley reported for the committee as follows:

The committee is unable to present a written report on account of late date of promulgation by the commission of the boiler inspection rules.

Last year, due to legislation in Congress, it was thought wise for the association to put itself on record, so far as it could out of convention, in regard to getting out a set of rules covering minimum requirements of boiler inspection. The committee met and got out such a set of rules, and sent them out in a circular dated September 8, 1910. These rules were submitted to the membership. They concluded with a request for an informal ballot to get the mind of the Association, and they were carried practically unanimously, the negative votes being insignificant in number. These rules were brought to the notice of those handling the legislation, and, after the law had been passed the railways were invited by the chief boiler inspector to send representatives to a conference at Washington to discuss the matter of the rules, and a Conference Committee of mechanical officers—appointed as a sub-committee of the Special Committee on Relations of Railway Operation to Legislation—discussed the matter with the inspectors and the representatives of the employees, arriving at a set of rules with which you are probably familiar through Bulletin No. 17 of the Special Committee. Those rules were revised and finally acted upon at a hearing before the Interstate Commerce Commission on May 29, and were issued, with the ruling of the Commission, under date of June 2, 1911, and they have been distributed to the railways.

This ruling of the Commission and the rules which have been materially changed from those in the above-mentioned Bulletin, No. 17, are given as follows:

Whereas the fifth section of the act of Congress approved February 17, 1911, entitled "An act to promote the safety of employees and travelers upon railroads by compelling common carriers engaged in interstate commerce to equip their locomotives with safe and suitable boilers and appurtenances thereto," provides, among other things, "that each carrier subject to this act shall file its rules and instructions for the inspection of locomotive boilers with the chief inspector within three months after the approval of this act, and after hearing and approval by the Interstate Commerce Commission, such rules and instructions, with such modifications as the commission requires, shall become obligatory upon such carrier: *Provided, however,* That if any carrier subject to this act shall fail to file its rules and instructions the chief inspector shall prepare rules and instructions not inconsistent herewith for the inspection of locomotive boilers, to be observed by such carrier; which rules and instructions being approved by the Interstate Commerce Commission, and a copy thereof being served on the president, general manager, or general superintendent of such carrier, shall be obligatory and a violation thereof punished as hereinafter provided," and

Whereas at the expiration of the period of three months after the approval of said act many of the common carriers subject to the provisions thereof had failed to file their rules and instructions for the inspection of locomotive boilers with the chief inspector; and

Whereas the chief inspector thereupon proceeded to prepare for submission to the Interstate Commerce Commission for its approval rules and instructions for the inspection and testing of locomotive boilers and their appurtenances for such carriers so failing to file the same; and

Whereas upon due notice there came on a hearing before the Interstate Commerce Commission in the matter of the approval and establishment of the rules and instructions prepared by the said chief inspector, on the 29th day of May, 1911; and

Whereas such carriers as had filed their rules and instructions for the inspection and testing of locomotive boilers and their appurtenances with the chief inspector within three months after the passage of said act asked, through their representatives at said hearing, that such of said rules and instructions which did not fulfill the requirements of the proposed rules and instructions prepared by the chief inspector be modified to the extent necessary to conform thereto, and that such of said rules and instructions as prescribed a higher standard than that required by the rules and instructions prepared by the chief inspector be regarded as withdrawn from consideration, and joined in a request that such rules and regulations as had been prepared by the chief inspector and approved by the Interstate Commerce Commission be established with uniformity for them and all other carriers subject to the act; and

Whereas at the hearing aforesaid the rules and instructions prepared by the chief inspector were submitted to the Commission for its approval and all parties appearing at said hearing were fully heard in respect to the matters involved, and said proposed rules and instructions having been fully considered by the Commission:

It is ordered, That said rules and instructions for the inspection and testing of locomotive boilers and their appurtenances, as follows, be, and the same are hereby, approved, and from and after the 1st day of July, 1911, shall be observed by each and every common carrier subject to the provisions of the act of Congress aforesaid as the minimum requirements: *Provided,* That nothing herein contained shall be construed as prohibiting any carrier from enforcing additional rules and instructions not inconsistent with the foregoing, tending to a greater degree of precaution against accidents:

Flues to be removed.—All flues of boilers in service, except as otherwise provided, shall be removed at least once every three years, and a thorough examination shall be made of the entire interior of the boiler. After flues are taken out the inside of the boiler must have the scale removed and be thoroughly cleaned. This period for the removal of flues may be extended upon application if an investigation shows that conditions warrant it.

Method of testing rigid bolts.—The inspector must tap each bolt and determine the broken bolts from the sound or the vibration of the sheet.

If stay-bolt tests are made when the boiler is filled with water, there must be not less than 50 pounds' pressure on the boiler. Should the boiler not be under pressure, the test may be made after draining all water from the boiler, in which case the vibration of the sheet will indicate any unsoundness. The latter test is preferable.

Flue plugs.—Flue plugs must be provided with a hole through the center not less than three-fourths inch in diameter. When one or more tubes are plugged at both ends the plugs must be tied together by means of a rod not less than five-eighths inch in diameter. Flue plugs must be removed and flues repaired at the first point where such repairs can properly be made.

Leaks under lagging.—If a serious leak develops under the lagging, an examination must be made and the leak located. If the leak is found to be due to a crack in the shell or to any other defect which may reduce safety, the boiler must be taken out of service at once, thoroughly repaired, and reported to be in satisfactory condition before it is returned to service.

The order is pretty clear. Without having had any legal advice in the matter I will say that as I understand it the railways that have filed rules have withdrawn them, and all the railways in the country will work under the set of rules which are attached to the order. In our own case we will make these rules supplement the rules of the railways for a reason which will appear later. The changes in the rules which are issued with the order, as compared with those which were handed to the Commission at the hearing, are in the arrangement of the rules in regard to the numbering of them; there are two minor changes in the wording, and one change in the arrangement, the Accident Report Rule being moved from its location in the former set of rules. None of these are, I believe, objectionable.

The order of the Commission includes copies of the report forms. It is desired that the railways print their copies of the monthly and annual reports of the identical size and the same arrangement as in the samples in order to have a similarity of reports for convenience of filing. There is no size given for the Quarterly Inspection Report or Cab Card. A number of us, however, are of the opinion that it is desirable to print it half the size of the other standard reports, which are 6 in. x 9 in., and half of that would be 4½ in. x 6 in. Some of our Chicago roads are working towards a standard card holder, so as to get it a matter of commercial manufacture in large quantities and at cheaper prices. The report also includes a Specification Card for locomotives, which will keep our mechanical engineers busy figuring out the dimensions and the strengths of present locomotives. The order concludes with a copy of the law.

Rule 12 reads as follows: "Any boiler developing cracks in the barrel shall be taken out of service at once, thoroughly repaired, and reported to be in satisfactory condition before it is returned to service."

As I would interpret that rule: These reports are our own, and we are not required to report repairs to the inspectors.

Tesing Boilers: Rule 17 to 20. These rules cover the annual test, and there are a great many items in the report which have to be filled in.

The monthly and the annual forms of reports have diagrams on their backs for filling in as to defective stay-bolts, but these are only the bolts which are allowed to run; therefore, any railway which desires to have a complete record of its stay-bolts will have to maintain its present boiler inspection forms, provided such forms carry with them diagrams of the broken stay-bolts. In our own case we will retain our Rock Island form and do our work just the same as we have heretofore, supplementing it with the government requirements.

Discussion.—It was very clear that this important Federal law is expected to result in considerable embarrassment to many of the railroads before a smooth and satisfactory working has been attained wherein all of the provisions may be carried out without delaying the handling of power. Many of the disputed points, however, were cleared up by Mr. Seley in closing the discussion.

D. F. Crawford (Penn) said that everything possible should be done in good faith to co-operate and assist the Federal and the State inspectors. He feels that it is possible to do a great deal with the gentlemen on the various State commissions to get them to adopt and use a Federal quarterly inspection card as covering the whole situation, the reports to be sent to the commission as may be decided by the various legal departments. Mr. Crawford added that inasmuch as the Federal Inspection Rules become effective July 1, time does not permit to refer the question of the size of the cab cards to the Committee on Standards, and moved that the association adopt as recommended practice the size 3 in. by 5 in., the library card size which will enable a copy to be kept, if desired, in the regular card catalogue file, which motion was put and carried.

R. D. Smith (B. & A.) mentioned that no particular trouble has been experienced on his road in carrying out this law, which is practically that of New York State under which he is operating, saying in part:

As I read this law, we will be obliged to have the certificates in the cab under glass, the same way that we now carry the certificate of the New York State inspection. It would seem to me, and I hope that some time action will be taken by this Association to that end, that it would be a good thing in some way to have the federal laws supersede the state laws. Our roundhouse clerks are notaries public and the inspectors go before them and make out their inspection reports, and they are sworn to and forwarded in the regular way. This is not done at one time, but it is a continuous performance. It goes on daily, and it goes on at night as well as in the day time. In engine houses where we have a large number of engines the night clerks are notaries as well as the day clerks. The copy of the law did not reach my desk until just as I was leaving the office, and I am not familiar with the time which we are to be given to fill out the specification cards for boilers. Of course, those of us who have had engines running in the State of New York can get copies of those specification cards, which will make very much less work than stated by Mr. Seley is necessary, but I do know how much time we have in which to file these cards.

The report was also discussed by Messrs. Haig (A. T. & S. F.), Enright (D. & R. G.), E. A. Miller (N. Y. C. & St. L.), and other members, which brought out a clearer understanding of the requirements.

MINIMUM REQUIREMENTS FOR HEADLIGHTS

The committee has gotten together considerable information on this subject from railways and also a great deal of data concerning tests on various headlights made at Purdue University, and some tests of a number of headlights which were made at the United States Bureau of Standards. This data is rather conflicting, and the committee would ask to be continued for another year, hoping at that time to submit a full report to the convention. The request was granted.

REVISION OF STANDARDS

Commitee:—T. W. Demarest, J. D. Harris, H. T. Bentley.
[No report was presented by this committee.]

SAFETY VALVES

The report of this committee was received too late for approval and will be presented next year.

ADVISORY-TECHNICAL

Committee—G. W. Widen, chairman; A. W. Gibbs and W. A. Nettleton.

A progress report was made by the chairman, who stated that many subjects were under consideration and that a report would be made on them next year.

[Abstracts of reports and discussion on the following subjects will appear in the August issue: Smoke Preventing Devices for Firing Up Locomotives at Terminals; Flange Lubrication; Best Method of Treating Water; Best Construction of Locomotive Frames; Piston and Crossheads, and Steel Tires. —Ed.]

Railways of the World in 1909.—The *Archiv für Eisenbahnwesen* has issued its regular yearly railway statistical statement covering the railways of the world. Its latest figures are for the year 1909 and show the mileage of North America to be 277,015 miles, Europe 204,904 miles, Asia 61,800 miles, South America 42,329 miles, Africa 20,809 miles and Australia 18,849 miles. This indicates that more than one-half the total railway mileage of the world is found in North and South America, North America alone having over 10,000 miles more than Europe and Asia combined, notwithstanding the fact that the latter continents have 1,250 million inhabitants as against 115 million in North America.

An Alarm for Hot Bearings consists of a small tube and bulb containing mercury so arranged that rise of the mercury due to temperature closes an electric circuit and rings a bell. The apparatus is attached to the bearing in a box 2 in. square. When several bearings are connected an ordinary electric-bell indicator can be used to show which is becoming hot.

Master Car Builders' Association

FORTY-FIFTH ANNUAL CONVENTION.

ABSTRACTS OF THE REPORTS OF THE STANDING AND SPECIAL COMMITTEES AND OF THE DISCUSSION THEREON AS WELL AS THE ACTION TAKEN IN EACH CASE.

The president, T. H. Curtis, superintendent of motive power of the Louisville & Nashville Railway, opened the 45th annual meeting of the Master Car Builders' Association on Young's Million Dollar Pier at Atlantic City, June 19th, 1911. After prayer by the Rev. Dr. Caldwell, the president called upon William McWood, the oldest ex-president of the association, who presided in 1887 to 1890, to address the meeting.

Mr. McWood spoke briefly, following which the president delivered his address, forcibly drawing attention to the great importance of several subjects that were to come before the association at this meeting, as well as suggesting other features that should be considered in the near future. This address in part is given below.

Safety Appliances.—The past year has been a very eventful one in the history of this Association and we have before us for immediate consideration several very important subjects. The twenty-fourth annual report of the Interstate Commerce Commission contains a report of the chief inspector, J. W. Watson, in the summary of which it is shown that in the year ended June 30, 1910, nearly a half million freight cars were inspected and a little over 5 per cent. were found to be defective. When comparing these figures with those for the year ended June 30, 1905, in which about one-fourth of a million freight cars were inspected and over 22 per cent. were found to be defective, we have the comfort of knowing that an improvement was made, but there is still room for further effort. The comparative classified table of defective safety appliances on freight cars, for the year ended June 30, 1910, as to couplers and uncoupling devices, shows over 5,000 defective appliances. Over 1,500 of these defects were in the uncoupling chains. These could have been practically obviated by the use of a first-class chain that would not have cost over 15 cents. Over 2,000 more of the defects reported could have been righted within an average of one-half hour's time for each defect, and at a cost of not over 50 cents each. Over 6,000 cases of defects were reported in handholds, ladders and sill-steps. Of this number, over 600 were for missing sill-steps and nearly 4,000 for missing handholds. These omissions are to be deeply regretted. As to air brakes, over 16,000 cases were reported, of which over 6,000 were for brakes cut-out and over 2,000 for cylinder and triple valves not having been cleaned within the prescribed time. There were over 2,000 cases of release rods missing. These rods do not cost over 10 cents each.

Of the 16,000 defects cited, 10,000 of them could have been repaired by detaining the car from service only a half day at the most, and these repairs would have required only labor and they would not have required the services of large shops and machinery. The greater portion of the defects mentioned could have been obviated by greater care and supervision, and this supervision should have come from the higher officers. They should have known that the car men were properly instructed and drilled in regard to the importance of properly applying and maintaining safety appliances.

The matter of proper application and maintenance of safety appliances is of great importance. On July 1, 1911, the United States safety appliance standards as set forth in the order of the Interstate Commerce Commission of March, 1911, will become effective. While these standards may not be looked upon favorably by some, they are the result of many conferences and hard work by a committee of inspectors for the Interstate Commerce Commission and the general committee of railways on safety appliance standards, composed of members of our Association, the American Railway Association and others, and it is to be hoped that every effort will be put forth on the part of the members of this Association to familiarize themselves with these standards with a view to properly applying and maintaining them. And, furthermore, I urge you to co-operate with the Interstate Commerce Commission representatives, and by this co-operation the object of the law will be attained and uniformity will be the result, as well as good feeling between all concerned. One result of the enforcement of the safety appliance law will be the bringing into use of common standards for safety appliances for all classes of rolling stock equipment, regardless of the ownership of the equipment, whether it be a railway company or a private car line.

M. C. B. Standard Coupler.—A common standard in railway equipment, which is being interchanged, is a necessity—it is the need of to-day. To further profit by a common standard for equipment it is earnestly recommended that the Master Car Builders' Association speedily adopt a standard M. C. B. car coupler, and that this coupler must be standard in all of its parts, and every railway to use it only. The day of experimenting with car couplers is past, the state of the art has reached its maturity. A common standard for a car coupler will reduce the great number of repair parts that are now required to be kept in stock all over these United States for repairs to the great number of different styles of the M. C. B. car coupler, which is now a standard only in its contour lines. In brief, the M. C. B. coupler of to-day is standard in service, but interchangeable only as a whole, as the various makes are widely different in details of construction. To facilitate the prompt movement of traffic and also raise the standard of efficiency and reduce the cost of operation, a standard M. C. B. coupler is a very present need. This subject of a standard car coupler was earnestly recommended by one of my worthy predecessors in his address to our Association.

Car Wheels.—The day for small or light capacity freight train cars, as well as passenger equipment cars, is about past. So-called heavy or large capacity cars are now being built extensively, and some have been in operation for a long time. In some cases the strains and stresses are possibly exceeding the limits of safety for certain kinds of material that have been heretofore commonly used. As a citation I will mention car wheels. The steel car wheel is now considered by some large railway companies to be a necessity. I will not comment on the steel car wheel or on the different kinds or makes and their mission in railway equipment of to-day, but will say that the time is at hand when something should be done by this Association in prescribing and requiring that under all heavy capacity cars an efficient and suitable car wheel must be used. The common cast-iron car wheel of a grade used under light cars with good results needs to be materially increased in its strength and stability if it is to be used in service under heavy capacity cars of to-day.

Consolidation.—For several years the subject of the consolidation of the M. M. and M. C. B. Associations has been under consideration. Consolidation is a subject for each member to give sincere consideration, for it may materially affect him. In detail of subjects the two associations widely differ, and yet both locomotives and cars are used in the same train, and under the same management. One would not consider a detail knowledge of the car department as fitting him for detail service in the locomotive department, or vice versa. We now have two associations to deal with two departments, which are different in detail. In the American Railway Association the railways have the consolidation of these two departments; that is, the locomotive and the car department, and this association includes many other departments. The American Railway Association is the executive head of all associations like the Master Mechanics' Association, Master Car Builders' Association and others, and therefore, it may not be wise or necessary to effect a consolidation of the M. M. and M. C. B. Association, especially as one of the associations that would form a part of the consolidation is not executive, and the other is not executive except in a limited degree.

If these two associations are consolidated and possibly called American Railway Mechanical Association, as suggested, it will be composed largely of the men that are now members of these two associations. This would possibly be very satisfactory to the men occupying the higher positions in railway service, but there would probably soon be formed two other associations, one of the subordinate heads of the locomotive department, and the other the subordinate heads of the car department, and these two associations would take up separately in detail those subjects that are close to the trade in which they are earning their livelihood, the same as the master boiler makers and master blacksmiths now consider subjects in detail that are close to their trade. This subject of consolidation needs much care-

ful thought and consideration on your part, and all matters should be fully weighed before any definite action is taken.

ASSOCIATION BUSINESS

Secretary Taylor reported that there were now 422 active members, 361 representative members, 13 associate members and 19 life members, giving a total membership of 815. The number of cars reported in the association was 2,464,530, an increase of nearly 166,000 during the year. The treasurer's report showed a balance of $7.39 for the transactions of the year and a surplus fund amounting now to $1,126.20. The annual dues were fixed at $4 per vote.

The name of Prof. E. C. Schmidt, University of Illinois, was presented for associate membership, and J. W. Marden (B. & M.) and J. W. Flemming (C. & O.) were proposed for life membership.

Under the head of new business F. W. Brazier (N. Y. C.) spoke most strongly concerning the work of the committee appointed to represent the association before the Interstate Commerce Commission on the subject of safety appliances, moving that a vote of sincere thanks be extended to them for their laborious duties and the very pleasant way in which they represented the association and brought about good feeling between the government and the railways. This motion was carried unanimously by a rising vote. This committee consisted of T. H. Curtis, A. W. Gibbs, C. E. Fuller, C. A. Seley and J. F. Deems.

H. H. Vaughan (C. P. R.) requested that the association establish a standard or limit for the height of the running board on the standard dimension box car and moved that the matter be referred to the Committee on Standards.

During the discussion it was brought out that there was a standard height for the top of a brake shaft and a standard distance between running board and brake wheel, which practically made the standard height of the running board. This was finally disposed of by instructing the Committee on Standards to include this dimension in their report for the next year.

G. W. Wildin made a motion that the matter of cleaning of triple valves be referred to the Committee on interchange, with instructions to prescribe a minimum time after a valve had been cleaned when the owner should be required to pay for another cleaning. This subject was given considerable discussion, and it appeared that the trouble was due to improper cleaning at various points, and it was suggested that the name of the road doing the cleaning, as well as the date, be stenciled on the valve so that the source of the improper work could be determined. It was finally moved and carried that the subject of cleaning triple valves be referred to the committee on train brake and signal equipment, with instructions to report on the matters brought up during the discussion.

ELECTION OF OFFICERS

The following officers were elected: President, A. Stewart, Southern; first vice-president, D. F. Crawford, Pennsylvania; second vice-president, C. E. Fuller, Union Pacific; third vice-president, M. K. Barnum, Illinois Central; treasurer, J. S. Lentz, Lehigh Valley. Executive Committee—F. W. Brazier (N. Y. C. & H. R.), C. A. Schroyer (C. & N. W.) and A. Kearney (N. & W.).

SAFETY APPLIANCES

Committee:—Theo. H. Curtis, C. B. Young, Henry Bartlett, T. M. Ramsdell, M. K. Barnum, W. O. Thompson, A. LaMar.

The Committee on Safety Appliances has carefully considered this important subject in the limited amount of time that it has had since the issuance of the order of the Interstate Commerce Commission in the matter of United States Safety Appliance Standards, dated March 13, 1911, which is a modification of the original order issued October 13, 1910.

The United States Safety Appliance Standards prescribed in the Interstate Commerce Commission's order of March 13, 1911, must be applied to all equipment built on or after July 1, 1911.

As to applying the United States Safety Appliance Standards prescribed in the Interstate Commerce Commission's order of March 13, 1911, to equipment built prior to July 1, 1911, the order of the Commission prescribed the following:

"(a) Carriers are not required to change the brakes from right to left side of steel or steel-underframe cars with platform end sills, or to change the end ladders on such cars, except when such appliances are renewed, at which time they must be made to comply with the standards prescribed in said order of March 13, 1911.

"(b) Carriers are granted an extension of five years from July 1, 1911, to change the location of brakes on all cars other than those designated in paragraph (a) to comply with the standards prescribed in said order.

"(c) Carriers are granted an extension of five years from July 1, 1911, to comply with the standards prescribed in said order in respect of all brake specifications contained therein, other than those designated in paragraphs (a) and (b), on cars of all classes.

"(d) Carriers are not required to make changes to secure additional end-ladder clearance on cars that have 10 or more inches end-ladder clearance, within 30 inches of side of car, until car is shopped for work amounting to practically rebuilding body of car, at which time they must be made to comply with the standards prescribed in said order.

"(e) Carriers are granted an extension of five years from July 1, 1911, to change cars having less than 10 inches end-ladder clearance, within 30 inches of side of car, to comply with the standards prescribed in said order.

"(f) Carriers are granted an extension of five years from July 1, 1911, to change and apply all other appliances on freight-train cars to comply with the standards prescribed in said order, except that when a car is shopped for work amounting to practically rebuilding body of car, it must then be equipped according to the standards prescribed in said order in respect to handholds, running boards, ladders, sill steps and brake staffs: Provided, that the extension of time herein granted is not to be construed as relieving carriers from complying with the provisions of Section 4 of the Act of March 2, 1893, as amended April 1, 1896, and March 2, 1903.

"(g) Carriers are not required to change the location of handholds (except end handholds under end sills), ladders, sill steps, brake wheels and brake staffs on freight-train cars where the appliances are within 3 inches of the location, except that when cars undergo regular repairs they must be made to comply with the standards prescribed in said order.

"(h) Carriers are granted an extension of three years from July 1, 1911, to change passenger-train cars to comply with the standards prescribed in said order."

This order prescribes the following standards.*

The committee recommends that the Association's standards for safety appliances, Plates 19 to 19-P, be withdrawn and that the United States Safety Appliance Standards be substituted.

Plates 19-A to 19-P contain cuts showing the manner of application of safety appliances to the various types of cars and these plates also contain texts pertaining specifically to the car illustrated by the respective plate. These texts were a great help to car inspectors and others desiring to gain information quickly, and it is recommended by the committee that plates with texts of the United States Safety Appliance Sandards to cover the various types of cars be submitted at the next convention.

(NOTE.—The drawings for Plates 19-A to 19-P are in the hands of the Interstate Commerce Commission, and it is expected that copies will be received in time to distribute at the convention.—*Secretary.*)

Your committee recommends that designating marks for cars equipped with the United States Safety Appliance Standards be adopted.

The Interstate Commerce Commission's order prescribes that all cars built on or after July 1, 1911, shall be equipped with the United States Safety Appliance Standards, whereas there are various exceptions in the case of equipment built prior to July 1, 1911, it will be necessary to have two designating marks that a car may readily show whether it comes under the rules for equipment built on or after July 1, 1911, or under the rules for equipment built prior to July 1, 1911.

The committee recommends the following designating mark for cars built on or after July 1, 1911:

UNITED STATES
SAFETY-APPLIANCES
STANDARD.

and for cars built prior to July 1, 1911—

UNITED STATES
SAFETY-APPLIANCES

These markings to be used on each side of car; letters to be

* [Copies may be obtained upon request to the Sec. Interstate Commerce Commission, Washington, D. C.—Ed.]

not less than two (2) inches in height, with one-half (½) inch bar or staff of letter; arranged as nearly as possible to the spacing and arrangement as shown above.

Discussion.—Considerable discussion was aroused by the necessity of stenciling the words "U. S. Safety Appliances, Standard," on the cars or attaching a plate to the same effect. It was suggested that this be abbreviated to "U. S. S. A." or that an insignia or seal be attached which would mean the same thing, and take up much less room. The motion to this effect, however, was defeated.

The matter of distinguishing between cars which were standard in all particulars and those which during the next five years will be allowed to be operated with certain alterations, aroused considerable discussion, the point being that cars which were allowed to run were standard within the meaning of the law. It was finally pointed out by Mr. Seley that at the end of five years, when it will be necessary for all cars to be entirely standard, it will be a very difficult matter to take out those which need changes unless they were designated in some particular way, and that it was an understanding with the U. S. inspectors that this distinction would be made.

The report of the committee was then adopted.

REVISION OF CODE OF TESTS

Committee:—A. J. Cota, Chairman; J. R. Alexander, F. H. Scheffer.

CONDITION OF TESTS.

Construction of Rack.—Triple valves will be tested on a rack representing the piping of a one-hundred (100) car train. All cocks, angles and connections will be as nearly as possible identical with those in train service. The rack shall conform to blueprint No. C-11379 (Rev. 3-9-09) in the hands of the committee, which gives the proper fittings, piping, cylinders, auxiliary reservoirs, main reservoirs, automatic brake valves, etc.

Reservoir Capacity.—The main reservoir capacity shall be approximately 57,000 cubic inches.

The capacity of each auxiliary reservoir shall be such as will, with a pressure of 70 pounds, produce 50 pounds pressure in its brake cylinder when fully equalized in service application with 8 inches piston travel.

Air Supply.—The air supply for the test rack shall be obtained from a locomotive type of air compressor having a capacity of from 80 to 120 cubic feet of free air per minute. The compressor to be controlled by a single top-pump governor adjusted to maintain 110 pounds main reservoir pressure.

Brake-pipe Pressure.—Tests will be made with a brake-pipe pressure of 70 pounds, except when otherwise specified.

Brake-pipe Leakage.—With brake-pipe and auxiliary reservoirs charged to 70 pounds, the section of branch pipe between the cut-out cocks and triple valves, also the triple valves, should be tested with soap suds and leakage eliminated.

Branch pipe cut-out cocks should then be closed and brake valve placed in lap position; brake-pipe leakage should then not exceed 2 pounds per minute.

Brake Cylinders.—Brake-cylinder packing leathers must be maintained in good condition and free from leakage.

Piston Travel.—All tests shall be made with 8-inch piston travel, except when otherwise specified.

Construction of Triple Valves.—Triples must be so constructed that they can be secured and operated on apparatus conforming to Diagram No. D-15611 (which shows triple valve end of auxiliary reservoir, branch-pipe union and location of bosses for retaining valve pipe, with detail dimensions of each as well as detail dimensions between these parts when in the relative position they would occupy if triple valve were in place.)

Gauges and Recording Instruments.—The auxiliary reservoirs, brake pipe and brake cylinder of the 1st, 25th, 50th, 75th and 100th brakes shall be fitted with test gauges. All gauges must be calibrated and maintained in good condition.

Brake No. 1 shall be fitted with two recording pressure gauges, one to be connected to the brake-pipe branch pipe, the other to the brake cylinder, and brake No. 100 shall be fitted with a test gauge connected to the brake cylinder.

The attachment of electric circuit closers, also the general arrangement of the electric circuit wiring, shall be as shown on Plates A and A-1 (showing construction used on plant at Purdue University.)

Repetition of Tests.—Tests shall be repeated three times under the same general condition, a record being taken of each test, also the average result of each three tests. The room temperature at the time of the tests shall be recorded, also humidity.

Triple-valve Essentials.—The essentials of a quick-action triple valve are: first, charging; second, service applicaton; third, graduation; fourth, release; 5th, quick action.

INDIVIDUAL TRIPLE-VALVE TESTS.

NO. 1.—CHARGING TESTS.

Not less than three triples, selected at random, shall be tested, as follows:

With the triple valve cut out at the branch pipe cut-out cock; the auxiliary reservoir empty; and 90-pound brake-pipe pressure maintained, the triple valve should be cut in.

A. Under these conditions the auxiliary reservoir should be charged from 0 to 70 pounds in not more than 90 seconds nor less than 70 seconds.

B. When triple is in normal release position, the auxiliary reservoir should be charged from 0 to 70 lbs., in not more than 60 seconds and not less than 40 seconds.

NO. 2.—SERVICE APPLICATION TESTS.

Section "A."—(To determine sensitiveness to Service Application.)

1. Three valves, selected at random, shall be taken for this test and each tried separately. They will be tested on the first brake of the rack using the brake pipe only of the first car and locomotive, having the engine and tender brakes cut out.

2. These triple valves should apply in service when the brake-pipe pressure is reduced by direct discharge to the atmosphere through an orifice which will reduce brake-pipe pressure from 70 to 60 pounds, in 16 to 18 seconds, with brake valve and triple valves on locomotive and first brake cut out.

3. In preparing for this test, insert the required disk in union shown on Plate B with all cocks closed, after which open cock C and start test by opening cock B.

Section "B."—(Graduating Test.)

1. Three valves, selected at random, shall be taken for this test and each tried separately. They will be tested on the first brake of the rack, using the brake pipe only of the first car and locomotive having the engine and tender brakes cut out.

2. The first admission to the cylinder should be made with a reduction of brake-pipe pressure not exceeding 5 pounds; each

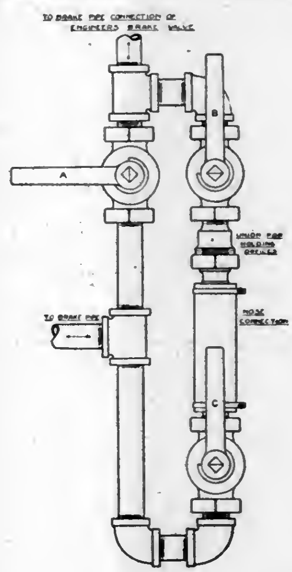


PLATE B.

succeeding reduction should reduce the pressure in the auxiliary reservoir not to exceed three pounds, until equalization takes place. The pressure in the brake pipe should not be more than 3 pounds lower than the equalized pressure in the brake cylinder and reservoir at equalization.

Section "C."—(Holding Test.)

Three valves selected at random will be taken for this test and each tried separately on the first brake on the rack, using the brake pipe only of the locomotive and the first car, having the triple valves cut out on engine and tender. The one brake will be applied, admitting as nearly as may be 15 pounds into the brake cylinder following a service applicaton. Record of pressures in the auxiliary reservoir cylinder and brake pipe will be taken as follows:

First. At completion of application.
Second. In five minutes.
Third. In ten minutes.
Fourth. In fifteen minutes.

In this test, when a constant brake-pipe pressure is maintained, the brake-cylinder pressure must not be increased more than 5 pounds in 5 minutes.

Section "D."—(Release test.)

Three triple valves, selected at random, shall be taken for

this test and each tried separately. They will be tried on the first brake of the rack using the brake pipe only of the first car and locomotive having the engine and tender brakes cut out. When the triple goes to normal release position it must exhaust the air from the brake cylinder from 50 to 0 pounds in not more than 15 seconds.

When the triple goes to retarded release position it must exhaust the air from the brake cylinder from 50 pounds to 0 pounds in not more than 40 seconds.

NO. 3.—EMERGENCY APPLICATION TESTS.

(To determine sensitiveness to quick action.)

Three triple valves, selected at random, shall be taken for this test and tried separately on the first brake of the rack. During this test the locomotive and tender triples are to be cut out.

Section "A."—These triple valves must give a quick-action application when the brake-pipe pressure is reduced by direct discharge to the atmosphere through disk with a 14/64-inch orifice.

Section "B."—These triple valves must not give a quick-action application when the brake-pipe pressure is reduced by direct discharge to the atmosphere through a disk with a 10/64-inch orifice.

Section "C."—(Holding Test.) Three triple valves, selected at random, shall be taken for this test and tried separately on the first brake on the rack.

The brake will be applied in quick action by moving the brake-valve handle to emergency position where it must remain until completion of test for the purpose of insuring the discharge of all brake-pipe pressure. Record of pressure in auxiliary reservoir and brake cylinder will be taken as follows:

First.—At completion of application.
Second.—In five minutes.
Third.—In ten minutes.
Fourth.—In fifteen minutes.

In this test, the auxiliary reservoir and brake-cylinder pressure must not show a reduction of more than 5 pounds in 5 minutes.

RACK TESTS.

NO. 4.—SERVICE APPLICATION TESTS.

Section "A."—(Service Equalization.)

With a service reduction of 25 pounds from brake-pipe pressure, a brake-cylinder pressure of not less than 48 pounds, nor more than 52 pounds, must be obtained.

Section "B."—(Graduating Test.)

1. A reduction of 5 pounds in brake-pipe pressure should apply lightly the 100 brakes. However, the brake-cylinder pressure may not be sufficient to show on all test gauges.

2. A further reduction of 4 pounds to 6 pounds should increase the cylinder pressure of all brakes.

3. A further reduction, making a total of 25 pounds, should equalize the pressure between the auxiliary reservoirs and brake cylinders.

Section "C."—(Service application time.)

Brakes will be applied by reducing brake-pipe pressure 10 pounds.

There shall not be more than 25 seconds difference in the time of obtaining 10 pounds pressure in the cylinders of the 1st and 100th brakes.

NO. 5.—EMERGENCY APPLICATION TESTS.

Section "A."—(Quick action, time and pressure.)

The 100th brake must be applied with at least 45 pounds pressure in 6¼ seconds from the movement of the brake-valve handle to emergency position and at least 55 pounds in 7 seconds. The final maximum pressure in this test must not be less than 15 per cent. nor more than 20 per cent. above the pressure given by the same brake in full service application.

This test will also be made to determine that quick action is obtained with:

First.—Four inches piston travel.
Second.—Twelve inches piston travel.

(NOTE.—The object of this test is to secure, as nearly as possible, uniformty of pressures in brake cylinders in an emergency application and uniformity of time required to obtain the pressures; to secure a minimum length of stop and a minimum of shock and of trains parting.)

Section "B."—(To determine whether quick action will follow a service application.)

Using the 100 brakes, make a service reduction such as will give 20 pounds cylinder pressure on the first brake. Then place the brake-valve handle in emergency position, which should cause quick action operation of all triple valves.

The pressure in the first cylinder will be increased or decreased by steps of about 5 pounds until the point at which quick action commences or ceases is determined.

Section "C."—(Quick-action jumping test.)

With brakes Nos. 1, 2 and 3 cut out, quick action should be obtained with the remainder of the brakes by an emergency reduction, and the time, from the movement of the brake-valve handle to emergency position to obtain 45 and 55 pounds cylinder pressure on the 100th brake, should not be increased more than one second over that required to obtain the same pressure with all brakes cut in.

This test should be repeated with groups of three brakes cut out, consisting of Nos. 2-3-4, 3-4-5, 4-5-6 and 5-6-7, and the time from the movement of the brake-valve handle to emergency position to obtain 45 and 55 pounds cylinder pressure in the 100th brake should be the same as with all brakes cut in.

These tests will also be made with piston travel of 4 inches.

NO. 6.—HOLDING TESTS.

Section "A."—(Following a service application.)

The one hundred brakes will be applied, admitting, as nearly as may be, 15 pounds into the cylinder of the first brake. Record of pressures in the auxiliary reservoirs and cylinders will be taken at all record points as follows:

First.—At completion of application.
Second.—In five minutes.
Third.—In ten minutes.
Fourth.—In fifteen minutes.

In this test any increase of brake-cylinder pressure should be in proportion to the reduction in brake-pipe pressure due to leakage.

Section "B."—(Following a quick-action application.)

The 100 brakes will be applied in quick action by placing the brake-valve handle in emergency position, where it will be left until completion of test, for the purpose of insuring the discharge of all brake-pipe pressure. Record of pressures in auxiliary reservoirs and cylinders will be taken at all record points as follows:

First.—At completion of application.
Second.—In five minutes.
Third.—In ten minutes.
Fourth.—In fifteen minutes.

The results of this test must not indicate an excessive amount of back leakage into brake pipe.

NO. 7.—RELEASE TESTS.

Section "A."—(Release Time.)

The 100 brakes shall be applied with an 18-pound service reduction of brake-pipe pressure and brake valve then placed in release position. Time will be taken from the movement of the brake valve into release position until pressure is reduced to 5 pounds in the cylinder of the first brake.

The pressure in the cylinder of the first brake should not reduce to 5 pounds in less than 18 seconds nor more than 25 seconds.

(NOTE.—Main reservoir pressure must be 110 pounds at time of release.)

Discussion.—E. W. Pratt (C. & N. W.) asked for information concerning the reason for using the reduction in brake pipe pressure under the service application test, while in emergency application a certain sized orifice was used to obtain the proper reduction. It was explained by the committee that because of the effect of the movement of the air in emergency application being almost instantaneous that it would be practically impossible to specify a time limit. Mr. Pratt also asked to have the type of brake valve specified, so that it might be standard on the testing rack. It was explained by the committee that any type of brake valve could be used.

The report was accepted and the recommendations submitted to letter ballot.

COUPLER AND DRAFT EQUIPMENT

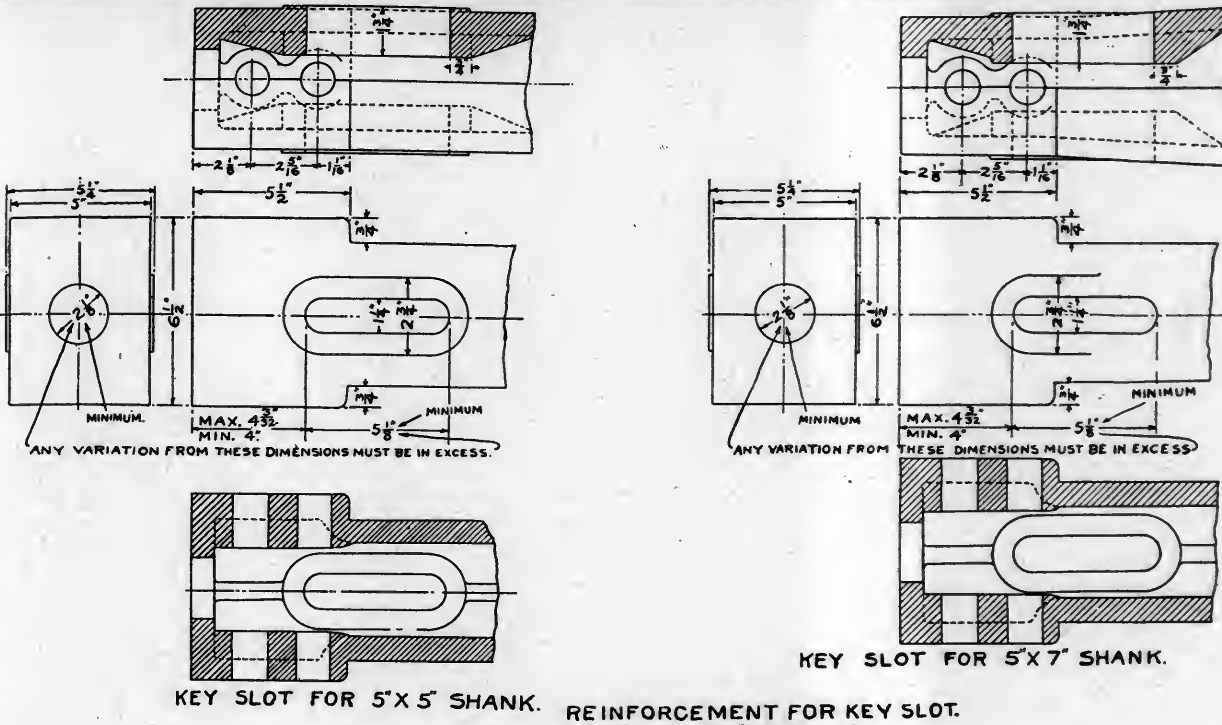
Committee:—R. N. Durborow, Chairman; G. W. Wildin, F. W. Brazier, F. F. Gaines, F. H. Stark, H. LaRue, H. L. Trimyer.

END-LADDER CLEARANCE.

Numerous inquiries were received from the members, relative to the question of redesigning the M. C. B. Standard coupler to provide the necessary end-ladder clearance on existing freight-equipment cars to comply with the United States Safety Appliance Standards. The committee has considered this questoin in its different phases and calls attention to the fact that the Association is confronted with a serious problem in the resultant effects, both to the railroad companies and the manufacturers, unless a proper solution of the matter is made at this convention.

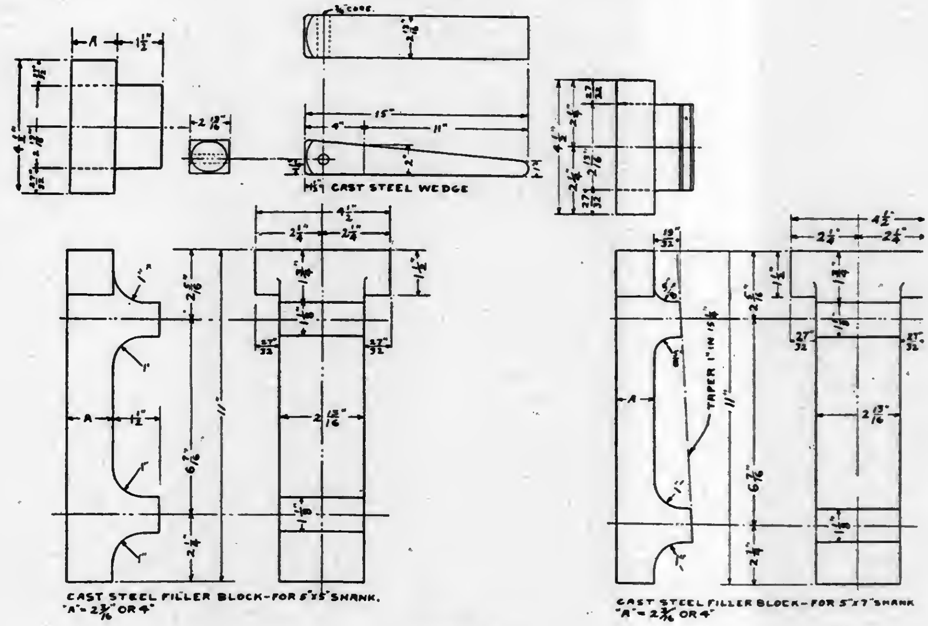
It is believed that the most satisfactory way of meeting the conditions imposed is to adopt one, or not more than two, temporary standard automatic couplers, so as to provide for the necessary end clearance as affecting present freight-equipment cars.

This proposed new coupler could be designed by lengthening the shank or by increasing the length of the head between the coupler horn and pulling face of knuckle; either of which would probably introduce conditions contributory to bending of shanks



REINFORCEMENT FOR KEY SLOT.
5"X5" AND 5"X7" SHANK,
AUTOMATIC COUPLER.

SHEET A.



SHEET B.

and breaking or buckling of center and end sills, due to the increased length of lever arm. The idea of gaining the required space by lengthening the shank should be discouraged, as it involves changes in the end construction of the car and a greater liability of bent coupler shanks, and your committee believes that the clearance required should be gained by changing the present standard distance between inside face of knuckle and striking horn of coupler.

It is desired that in thus providing for what may be termed an emergency condition that the Coupler and Draft Committee by no means intends to deviate from any fruitful results obtained by the Association in the past years, but rather to permit the introduction of this proposed coupler to meet what is nothing more than a temporary need. It should be kept clearly in mind that this emergency coupler is not to be placed on any new equipment, but is merely an expedient to meet a required condition. This change in coupler head would increase the number of M. C. B. Standard couplers. In order that the number of standards may be kept to a minimum, the members should advise your committee promptly the amount of increase in length of coupler necessary and the number of cars requiring this increase. When these replies are received it will enable the committee to decide whether it will be necesary to care for more than one additional temporary coupler. It should be borne in mind that it will be necessary to carry these emergency couplers in stock at all repair points, so as to maintain the proper end clearance when making repairs.

SUMMARY.

A summary of the recommendations which the committee offers to be submitted to letter ballot, to be adopted either as Standards or Recommended Practice, is as follows:

STANDARDS.

1. That the key-slot reinforcement for the 5 by 5 inch coupler be made 1¾ inches in thickness, as shown on Sheet A, and that the V-shaped reinforcement on both the 5 by 5 inch and 5 by 7 inch coupler be changed in design, as shown on Sheet A.

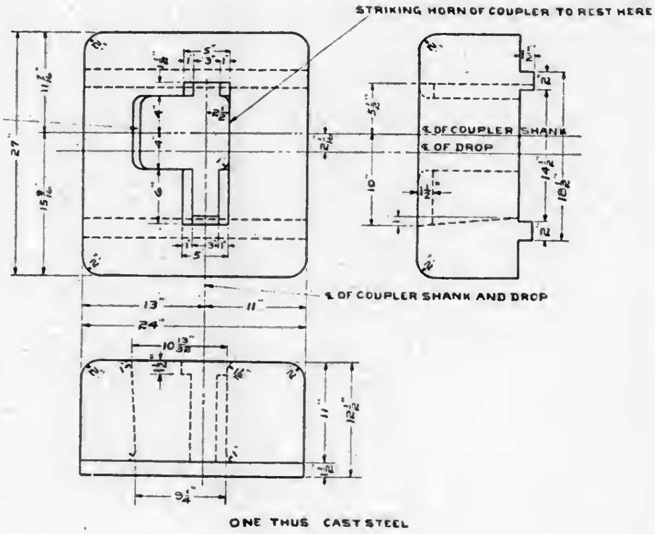
SPECIFICATIONS FOR M. C. B. AUTOMATIC COUPLER.

2. That the specification for M. C. B. automatic couplers, as

given on page 728, 1910 Proceedings, have the following sentence added after the words "Must not be painted," in the fourth sentence from top of page, "The word couplers as here used includes the bar itself and the contained parts within the head, such as locks, knuckle throws, etc."

3. That knuckle pins must bear a manufacturer's mark on head of pin.

4. That dimensions and bottom of coupler shank, Sheet 23,



SHEET C.

reading "12 inches, no projection here," be increased ½ inch forward toward head of coupler.

RECOMMENDED PRACTICE.

1. That the use of set-screws, shown on Sheet J, 1909 Coupler Report, for holding the coupler in place when making drop test, be abolished; that filler blocks and wedges, shown on Sheets B and E, be used instead of the set-screws, and that the base block, shown on Sheet I, 1909 Coupler Report, be changed to conform to that shown on Sheet C.

Discussion.—What afterwards proved to be practically universal sentiment was expressed by F. W. Brazier (N. Y. C.), who spoke strongly in favor of the designing of a standard coupler, speaking in part as follows:

In the convention of 1904 I suggested that a committee be formed to report the desirability of having a coupler designed standard so that the knuckle locks and other parts of the coupler would all be interchangeable. The coupler committee of 1905 recommended that a special committee be appointed to work in connection with the coupler committee. In the convention of 1906, the committee on the composite design of coupler, of which I was a member, made its report and great stress was then laid on the fact that none of the manufacturers were willing to give up their patent rights and surrender them to the association; also it was the opinion of the railway representatives of the committee that it was not in accordance with business ethics to ask the manufacturers to surrender their rights without compensation and the Master Car Builders' Association is not a body which can properly acquire rights of this character and sell them or give them to manufacturers, without rendering itself liabe to charges of unfair discrimination.

"It was also agreed by the committee that if we only had three or four kinds of couplers there would be less cause for complaint than at the present time. This committee concluded its report by commending that no couplers be purchased by railway companies unless they meet with the requirements of the M. C. B. Association and recommendations of the standard committee on tests of M. C. B. couplers and in this way the elimination of all couplers which do not fulfil the requirements would soon be effected. I am quoting the above to show the feeling at that time. I feel the time is come, and the experience that we have had with couplers is sufficient, so that we should get down to one standard design of couplers. My reasons are as follows:

"We have to carry so many different parts of couplers in stock to maintain the different kinds that it is great expense to the companies, a serious delay to freight and on a loaded car marked out for broken knuckle or knuckle lock of a coupler not standard to the line on which the failure occurs it is necessary, in order to make repairs, to remove the entire coupler and apply a new one complete. This means the application of a coupler not standard to the car. I find that the road I represent has in the past few months been compelled to order a little over 10,000 knuckles of 39 different makes; about 7,000 knuckle locks of 21 different makes; 246 knuckle lifters of different makes, and so on with other minor parts of couplers.

"In these days of economy when we are trying to keep our stock low, you can readily see what it means to have so many different kinds of couplers to maintain. Recently we had a statement made showing the number of second-hand freight couplers on hand that we were holding for repair to be a total of 2,015; 1,547 we were holding for knuckles; 1,435 of the 2,015 for locks, and the balance for other minor parts. This represented 26 different makes of couplers. From my viewpoint this is all uncalled for—the railway companies represented in the association could have a special committee, or the coupler committee meet with the coupler manufacturers, and, without doubt, a design of coupler could be agreed upon that would meet all the requirements. I feel positive about this point, as I have taken it up with several of the prominent coupler manufacturers, and I am assured that they would be willing to get together and settle this point.

"The second plan would be to have the coupler committee given power to design a coupler that meets the requirements, and that the association pay the necessary expense; then we would have a coupler with a knuckle that would be interchangeable for all couplers, and reduce the cost of our stock many thousand dollars a year, and also would save the delay of trains. A coupler arrangement should be provided at the same time, that would be operative either at the side or bottom and stop the trouble we are having with the top uncoupling arrangement. After 15 years of experience we know that either bottom or side uncoupling arrangement can be made absolutely satisfactory.

"At the present time, when one of these numerous couplers, which are not standard to our own lines breaks, we either have to set the car off, or possibly in some cases use an emergency knuckle, and under the Safety Appliance Law no two cars could be coupled together with them; neither could we interchange this car with a foreign line with an emergency knuckle in, simply because we have not a knuckle that would fit the coupler. Now, what is the result? This car goes to the repair track. The coupler is taken out. A coupler is put in that we have in stock. Then, rather than to throw away the foreign coupler, which was removed, we order a knuckle and hold the coupler body until we get the knuckle, which may be any time from 1 to 4 months. These are facts, and occurrences of this kind are happening every day on our roads. It is time that this association should wake up and take some action. I could give a great deal more data on this subject. I have the facts and figures with me showing the expense this means to the railways throughout the country as well as those I am representing.

"I wish to repeat what I have said before, that there is no reason why this one design of coupler cannot be brought about and be interchangeable the same as journal bearings, oil boxes and other parts of cars. I am told that it will stop competition. It may be very interesting to the members of this association to know that to-day there is no competition in couplers. The coupler manufacturers have apparently devised means whereby the couplers are all one price, so the argument of competition is the same in either event. I believe that we should give this subject more attention and more discussion than ever before in view of the alleged inefficiency of railway methods to which so much publicity has been given. I believe that a duty rests directly on this association now, and I certainly believe that this can be brought about at the present time better than at any time in the past."

J. F. Deems (N. Y. C.) emphasized what Mr. Brazier had said, and urged early action on the question.

Other members speaking in favor of the standard coupler were J. J. Hennessey (C. M. & St. P.), J. F. Walsh (C. & O.), C. E. Fuller (U. P.), and H. L. Trimyer (S. A. L.). C. A. Schroyer (N. & W.) believed that the knuckle, at least, should be made standard, while the details of the locking arrangement were not so necessary.

It was moved by G. W. Wildin (N. Y., N. H. & H.), and seconded by William Garstang (Big Four), that the committee on coupler and draft equipment be instructed to design a M. C. B. coupler and authorized to take the matter up with the coupler manufacturers and invite them to join the committee in designing and adoping a standard freight car coupler. This motion was discussed at some length with little opposition and was adopted.

M. K. Barnum (Illinois Central) made a motion that the committee be authorized to incur such expense for employment of a mechanical engineer, or other assistance, that might seem justifiable. This motion was carried.

A motion by Mr. Gaines (C of G.) to the effect that couplers with 11¼ in. length be submitted to letter ballot, was actively

discussed and, apparently largely on the basis of a new standard coupler to be presented next year and the objection to having a temporary standard in existence, the motion was lost.

It was then moved and carried that the recommendations of the committee be submitted to letter ballot.

The immediate need of a temporary coupler was again forcibly brought to the attention of the meeting by Mr. Seley and a motion was made by him that the committee be instructed to prepare a design and submit it to the executive committee with as much speed as possible, was carried. It is the intention of the executive committee to submit this to letter ballot before the next convenion.

REVISION OF STANDARDS AND RECOMMENDED PRACTICE

Committee:—R. L. Kleine, Chairman; W. E. Dunham, T. H. Goodnow, W. H. V. Rosing, C. E. Fuller, O. C. Cromwell, T. M. Ramsell.

STANDARDS.

JOURNAL BOXES AND DETAILS FOR JOURNALS 5½ BY 10 INCHES.

The committee concurs in the following recommendations, and suggests that they be referred to letter ballot.

Journal boxes for the heavier capacity equipment are being made of pressed and cast steel, and in order that the standards may be up to date, the following changes in the notes on Sheet 11 are recommended:

Section of box may be made either circular or square below the center line and material may be cast iron, malleable iron, pressed steel or cast steel; provided all the essential dimensions are adhered to.

When journal box is made of material other than cast iron, reduction in thickness of metal and coring to lighten weight is permissible, provided all the essential dimensions which affect interchangeability and the proper fitting of contained parts are adhered to.

If the method of manufacture does not permit of placing the letters "M. C. B." on the side of the journal box they may be placed on the top between the hinge lug and seat of truck sides.

JOURNAL BEARING WEDGE FOR JOURNALS 5½ BY 10 INCHES.

With reference to the manufacture of forged journal-box wedges, it is the opinion of the committee that this is a question for the railroads using these wedges to see that they are provided with wedges of the proper dimensions and shape regardless of whether they be forged steel or malleable iron. There is no evidence submitted that these wedges do embed themselves in the journal boxes, and it does not seem that the Association can govern the manufacture of the wedges any more than prescribing the proper Standard.

AXLES.

The committee is not in favor of having more than one limit for the minimum diameter to which the journal and wheel seat may be worn as this would lead to too much confusion in the shops. It is thought that without increasing the present number of axles and without changing the minimum diameters of journal and wheel seat, the present table of capacity markings for cars could be so amended as to permit variations in the capacity markings of the cars (minimum variations 5,000 or 10,000 pounds) by adding to the table the maximum load for which the representative axles were designed, and by deducting from this maximum load the light weight of the car and the overload of ten per cent., which would give the correct capacity to be stenciled on the cars. For the consideration of the members before any definite action is taken.

LIMIT GAUGES FOR INSPECTING SECOND-HAND WHEELS FOR REMOUNTING.

The committee recommends:

A. That the note under limit gauge shown on Sheet M. C. B. 16-A be changed to read: "For remounting cast-iron wheels cast prior to the M. C. B. standard tread and flange adopted in 1909.

B. That drawings be added showing the limit gauge for cast-iron wheels with M. C. B. tread and flange adopted in 1909, reducing the limit for height of flange from 1 5/16 inches to 1 3/16 inches, and a note added under these gauges reading as follows: "For remounting cast-iron wheels with M. C. B. standard tread and flange adopted in 1909."

AIR BRAKES—GENERAL ARRANGEMENT AND DETAILS.

The committee approves the suggestion of a member that to conform to U. S. Safety Appliance Standards the paragraph referring to hand-brake chain should be changed to read: "Brake chain shall be of not less than ⅜-inch, preferably 7/16-inch, wrought iron or steel, with a link on the brake-rod end of not less than 7/16-inch, preferably ½-inch, wrought iron or steel, and shall be secured to brake-shaft drum by not less than ½-inch hexagon or square-head bolt. Nut on said bolt shall be secured by riveting end of bolt over nut.

AIR BRAKES—GENERAL ARRANGEMENTS AND DETAILS.

The committee believes that cast steel of proper section is suitable for truck-lever connection and would suggest that a note be added to Sheet M. C. B. 18 reading as follows: "Cast steel may be used for truck-lever connection if of equal strength to the section of wrought iron or steel specified."

LABEL FOR AIR-BRAKE HOSE.

The committee recommends that the label and text (paragraph 7, page 709) referring to same be omitted from the specifications for air-brake hose and placed under the label for air-brake hose, paragraph 7, to be changed to read as follows: "Each length of hose must have vulcanized to it the label for air-brake hose of white or red rubber as shown under the specifications, Label for Air-brake Hose. Each lot of 200 or less must bear the manufacturer's serial number commencing at one on the first of the year, and continuing consecutively until the end of the year. For each lot of 200, one extra hose must be furnished free of cost.

Change second paragraph on page 711 under the heading of "Specifications and Tests for Woven and Combination Woven and Wrapped Air Brake Hose," to read: "Each length of hose must have vulcanized to it the label for air-brake hose of white or red rubber as shown under the specifications 'Label for Air-brake Hose.'"

Change second paragraph under the heading "Label for Air-brake Hose," page 712, to read: "Each length of hose must have vulcanized to it a standard air-broke hose label of white or red rubber as shown. The following information must be branded on the label: On the top of the badge the initials or name of road or purchaser and the size 1⅜ inches: on the bottom the name of manufacturer; on the left-hand end the month and year of manufacture; on the right-hand end the serial number and the letters M. C. B. Standard; and in the center field the years, letters A and R, and the numerals for the month to show the date of application and removal. These letters and figures must be clear and distinct, not less than ¼-inch in height, excepting name of manufacturer, which must not be less than ⅛-inch in height, and stand in relief not less than 1/32-inch. Letters and figures covering the application and removal of the hose must be so applied that they can be removed by cutting without endangering the cover."

LABEL FOR AIR-BRAKE HOSE.

Dimensions of label to be 4 by 2½ inches. Extensions may be made on right-hand end.

The label shown on Sheet M. C. B. 18 to be omitted from this sheet and included on a new Sheet 18-A full size.

No change has been made in the air-brake hose label aside from increasing the size of letters and numerals from 3/16-inch to ¼-inch in height, and name of manufacturer, which has been specified to be not less than ⅛-inch in height. The text has been revised to correspond with label.

The committee concurs in the suggestion of a member that we should add a paragraph to the specifications, Label for Air-brake Hose, page 713, to cover fitting up hose to the couplings and nipples so that the label on the hose will show toward the side of the car in such a position that the car inspectors can readily read the label from the side of the car. This matter should be referred to letter ballot for adoption as Recommended Practice, and, if approved, proper reference should be made in the text and included under Sheet M. C. B.—Q.

SAFETY APPLIANCES.

Pages 715 to 722, Sheets M. C. B. 19 to 19-B.

The committee approves the suggestion to adopt the Recommended Practice for brake details shown on Interstate Commerce Commission Plate "A" as follows: "Brake wheels both flat and dished 15 inches and 16 inches diameter, brake ratchet wheel, brake ratchet-wheel pawl and brake ratchet-wheel pawl plates." Also that the text and sheets be revised to conform to Interstate Commerce Commission requirements.

HEIGHT OF COUPLERS.

Committee suggests that the text be modified to conform to the order of the Interstate Commerce Commission dated October 10, 1910, reading as follows: "The maximum height of drawbars for freight cars measured perpendicularly from the level of top of rails to the centers of drawbars for standard-gauge railroads shall be 34½ inches, and the minimum height of drawbars for freight cars on such standard-gauge railroads measured in the same manner shall be 31½ inches, and on narrow-gauge railroads the maximum height of drawbars for freight cars measured from the level of tops of rails to the centers of drawbars shall be 26 inches, and the minimum height of drawbars for freight cars on such narrow-gauge railroads measured in the same manner shall be 23 inches, and on 2-foot gauge railroads the maximum height of drawbars for freight cars measured from the level of the tops of rails to the centers of drawbars shall be 17½ inches, and the minimum height of drawbars for freight cars on such 2-foot gauge railroads measured in the same manner shall be 14½ inches.

RECOMMENDED PRACTICE.

JOURNAL BOX AND PEDESTAL FOR PASSENGER CARS FOR JOURNALS 5 BY 9 INCHES.

The committee recommends the following:

(a) Sheet A, 5 by 9-inch passenger journal box, change mouth of box and dust-guard opening to conform to freight box and advance to Standard.

(b) Pedestal for 5 by 9 journal box shown on Sheet B advance to Standard.

CAST-IRON WHEELS.

The committee believes that the specifications for cast-iron wheels should be advanced to Standard, but before doing so should be referred to the Wheel Committee for any changes or corrections that may be necessary.

AIR-BRAKE APPLIANCES.

The committee concurs in the recommendation that the steam and air line connections for passenger cars be advanced to Standard.

The committee recommends that the three sheets M. C. B.—J, K and L, be referred to the Committee on Train Brake and Signal Equipment for revision to conform to the U. S. Safety Appliance Standards adopted March 13, 1911, which provide that the hand-brake shall operate in harmony with the power brake.

STEAM AND AIR LINE CONNECTIONS.

The committee concurs in the recommendation that air-brake hose must be 1⅜ inches inside diameter, but does not approve the 1⅛-inch diameter for air-signal hose. It also recommends that the heading on page 775 be changed to read: "Steam and Air Connections for Passenger Cars."

The committee recommends that the angle cock shown on Sheet Q be changed to show 30 degrees from the vertical.

UNCOUPLING ARRANGEMENTS FOR M. C. B. COUPLERS.

The committee recommends to advance to Standard the clevises, links and pin now shown on Sheet C, and to include Plate B and text governing the uncoupling levers of the U. S. Safety Appliance Standards, adopted by order of the Commission dated March 13, 1911, in the standards of the Association.

COUPLER YOKES.

The committee concurs in the recommendation that the yoke for the twin spring gear, yoke for tandem spring gear and yoke for friction gear be advanced to standard, and suggests that they be shown on a new Sheet No. 23-A.

DROP-TEST MACHINE.

The committee concurs in the recommendation that the drop-test machine for M. C. B. couplers and knuckle pins be advanced to standard.

SIGNAL-LAMP BRACKETS AND SOCKETS.

The committee suggests that the slotted and tapered dimensions be shown, the other details of the bracket omitted, and advanced to Standard.

BRAKE CHAINS.

The committee concurs in the recommendation to advance brake chains shown on Sheet M. C. B. 18 to Standard.

BOX-CAR OUTSIDE-HUNG SIDE-DOOR FIXTURES.

The committee approves the suggestion that door-hasp staple, shown on Sheet M. C. B.—F, be increased in length from 5⅜ inches to 16 inches, to provide for four bolts, for fastening staple to door. The present hasp staple is causing trouble, due to pulling through the wood on account of insecure fastening.

STANDARD LOCATION FOR CAR-DOOR SEALS.

At a special meeting of the General Managers' Association of the Southeast, held on September 9, 1910, the following resolution was unanimously passed:

"*Resolved*, That it be the sense of this meeting that car-door fastenings should be located 5 feet above top of rail and 1 foot above the floors of the cars, and it is recommended to all lines that they include these specifications for all new equipment, and that it be made a rule to alter the location of door fastenings for all cars going through the shops for general overhauling to conform to this standard."

It was further stated that this action will be communicated to the Master Car Builders' Association, the various General Managers' Associations and to the American Railway Association, the cause for this action being the present difficulty in procuring proper seal records, by reason of the seals on most cars being so high from the ground that those entrusted with the duty of procuring the sealing records cannot read them.

The committee has given this matter very careful consideration, and would call the attention of the members to Sheet M. C. B.—F, Box Car Outside Hung Side Door, on which the hasp to which the seal is attached is located "about 5 feet 6 inches from the top of rail," and to Sheet M. C. B.—F-1, Box Car Flush Side Door, on which the hasp to which the seal is attached is located "5 feet 6 inches from top of rail." Flush doors of the description shown on Sheet F-1 are sealed both at door-rod handle and at the hasp, therefore, the sealing dimension should be shown at the door-rod handle as well as at the hasp. On some refrigerator cars, on account of the double-door bar-lock construction, it is difficult to bring the sealing eye lower than 5 feet 8 inches above the top of rail, and on box cars equipped with vertical door rods sufficient clearance must be allowed between the top of station platform and the handle of the door rod for proper manipulation of the door-rod handle.

It is unquestionable that the seal should be located on the doors within reasonable reading distance from the ground in order to facilitate application and inspection of the seals, and the committee would recommend the following: Center of hasp or sealing eye should be located not less than 5 feet above top of rail nor more than 5 feet 9 inches above top of rail. These dimensions to be shown on Sheets F and F-1 and proper reference made in the text.

MARKING OF FREIGHT EQUIPMENT CARS.

The suggestion to add the station symbol where car is weighed is approved.

STENCILING CARS.

The committee suggests that the word "stenciling" in index and text be changed to "lettering," to conform to the wording on Sheet M.

LIMIT GAUGES FOR ROUND IRON.

The Executive Committee referred to the Committee on Revision of Standards and Recommended Practice, the following: To investigate and report on whether any changes are necessary in the present Recommended Practice covering the diameters of round iron.

At the present time the Recommended Practice does not show any limits for sizes of round iron more than 1⅝ inches in diameter; furthermore, a manufacturer has asked that the limits be increased for bars 1⅜ inches and over in diameter, claiming that the present limits are rather close for rolling-mill practice, and can only be met under special conditions and with special care, which means a special price.

The committee, after carefully considering this question, believes it will be entirely proper to adopt the Standards of the Master Mechanics' Association for the allowable variations, both below and above the nominal size for round iron 1½ inches and more in diameter. Revised table is given below:

Nominal Diameter of Iron, Inches.	Large Size Inches. End.	Small Size Inches. End.	Total Variation Inches
1½	1.5115	1.4885	.023
1⅝	1.6370	1.6130	.024
1¾	1.7625	1.7375	.025
1⅞	1.8880	1.8620	.026

Round iron 2 inches in diameter and over should be rolled to nominal diameter.

SPLICING OF STEEL CENTER SILLS.

SPLICING OF WOODEN SILLS.

The committee recommends:

(a) To advance text on pages 782 and 783 on splicing of sills, steel and wooden, to Standard, and omit reference in the text to draft sills, as the latter are misconstrued in some quarters to mean draft timbers.

(b) Advance Sheet D to Standard, and add a note under Fig. 9-B, reading, "Center sills," and a new Fig. 9-C, reading, "Intermediate and side sills."

(c) Change Fig. 9-B to Fig. E, and change Fig. 9-C to Fig. F.

Discussion.—There was objection raised to the recommendation to omit from the volume of proceedings the code of interchange laws. This matter was finally decided by the passing of a motion made by Mr. Seley that the code of interchange rules and the rules for loading long material be incorporated in the proceedings, while the arbitration committee's proceedings should be eliminated.

The matter of the height of hasp or seal pin on doors was given considerable discussion, and it was finally decided to make this recommendation read that the height should be at 5 ft. with allowance variation, instead of between 5 ft. and 5 ft. 9 in. as recommended by the committee. This change was accepted by the committee and a motion to refer the report, as thus amended to letter ballot was carried.

Among the matters in the committee's report which were to be brought before the convention for decision the subject of the marked carrying capacity of cars being raised in proportion as the dead weight of the car was reduced, i. e., that the total weight of car and load should remain constant, was given an active discussion. There was considerable objection raised to the matter of marking up car capacities by means of a paint brush, while other members believed that any saving in the dead weight of the car which they were able to make by design should be added to the revenue capacity of the car. It was pointed out by M. K. Barnum (I. C.) that there were many features concerned with this subject and he made a motion that the matter be referred to a special committee for a report next year. This motion was seconded by Mr. Hennessey and carried.

TRAIN BRAKE AND SIGNAL EQUIPMENT

Committee:—R. B. Kendig, chairman; T. L. Burton, B. P. Flory, E. W. Pratt, R. K. Reading.

Piping Arrangement for Steel Cars.

From replies received to Circular of Inquiry requesting certain information concerning the foundation brake arrangement on steel cars and steel-underframe cars, it would seem, having in mind the greatest degree of accessibility, that the practice of locating brake pipes is, in a general way, uniform. Since this subject was assigned to your committee two years ago, the railroad car designers, the air-brake manufacturers and the car manufacturers have had considerable additional experience in designing air-brake pipe arrangements. There are so many different types of steel cars now in existence, to say nothing of the future, that the committee believes it could not present piping arrangements that would be suitable for all cases, and no recommendation of a piping arrangement for steel cars is, therefore, deemed necessary.

AIR-BRAKE DEFECT CARD.

The committee would make the following recommendations:

(a) A defective air-brake card, as shown by Fig. 1, to take the place of the present air-brake cutout card and defective air-brake card.

(b) A revision of the defects enumerated on the present air-

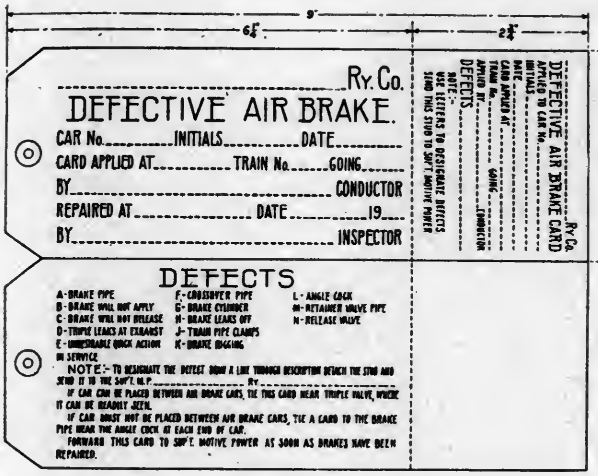


FIGURE 1

brake cutout card and air-brake repair card to read as shown on the proposed defective air-brake card, Fig. 1.

(c) The use of card to be designated by its location on car, as follows:

(1) If car can be placed between air-brake cars, wire this card near triple valve, where it can be readily seen.

(2) If car must not be placed between air-brake cars, wire card to brake pipe near angle cock at each end of car.

(d) The color of defective air-brake card to be red.

(e) The size of defective air-brake card to be 3¼ by 9 inches, including the stub, which is 3¼ x 2¾ inches.

(f) Card to be fitted with eyelet, as shown in Fig. 1, and each card supplied with suitable wire for attaching to car.

EFFICIENT TRUCK BRAKE FOR CARS EQUIPPED WITH ALL-STEEL OR STEEL-TIRED WHEELS.

From a compilation of the data received in answer to Circular of Inquiry of the Wheel Committee the committee has assumed, for the purpose of consideration of this subject, a diameter of 30 inches when wheel is worn to limit.

By making several truck-brake layout drawings it was found that the additional brake travel due to decreased diameter of wheels can be readily taken up by means of additional holes in the bottom connection rod jaws.

The committee recommends that sketch of bottom rod, detail Fig. 2, to be shown on Plate 18, to cover bottom-rod details for cars having inside-hung brakes and equipped with all-steel or steel-tired wheels; the inside pin holes to be used with new wheels.

IV.—ANGULARITY OF BRAKE-BEAM HANGERS.

This subject is somewhat involved by the increasing use of all-steel and steel-tired wheels on freight cars, with the consequent difference in diameter of wheels when new and worn to limit.

The Wheel Committee has made recommendations as to maximum diameter for all-steel and steel-tired wheels, but has left open the question of diameter when wheel is worn to limit. It is obvious that an angle of brake beam hanging suitable for a new 33-inch wheel would be objectionable when wheel is worn to limit, and some compromise angle would have to be selected.

The committee recommends, therefore, that the question of advancing to standard the before-mentioned practice be deferred

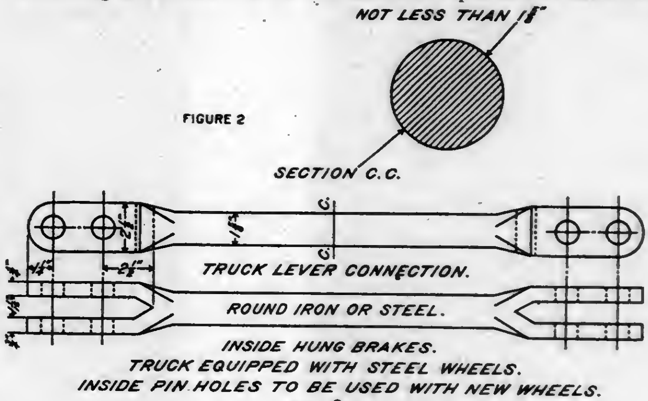


FIG. 2.

until it has more data and time for consideration of the subject.

V.—TRIPLE VALVE TEST RACK AND CLEANING AIR BRAKES.

In pursuance to the suggestion outlined at the 1909 convention, a member of the Association's Committee on Train Brake and Signal Equipment had placed in freight and coal service on the Philadelphia & Reading Railway, and the Central Railroad Company of New Jersey, during the latter part of 1909 and the early part of 1910, 1,500 Westinghouse K-2 triple valves containing no lubricant: also, for comparative test, 1,000 additional triple valves which had been lubricated with a suitable composition of oil and graphite.

A large number of the lubricated and non-lubricated valves were removed from the cars after they had been in service for twelve to fourteen months, and were carefully inspected and tested before and after cleaning.

Briefly stated, the investigation thus far shows the following results:

Lubricated Valves.—After being in service twelve to fourteen months, 65.66 per cent. of the valves tested passed all test before they were cleaned; 21 per cent. failed on charging the auxiliary reservoir in the prescribed time because of the valves being dirty.

After cleaning, 86.36 of the lubricated valves tested passed all test.

Non-lubricated Valves.—After being in service twelve to fourteen months, 37.2 per cent. of the valves passed all test before cleaning; thirty-six per cent. failed on charging the auxiliary reservoir in the specified time.

After cleaning, 90.69 per cent. of the non-lubricated valves tested passed all test.

All of the slide valves, slide-valve seats, bushing and packing rings were highly polished and showed no ill effects from lack of lubricant.

Eliminating the defects that caused the lubricated and non-lubricated valves to pass the prescribed test which would not be influenced by the application of lubricant, there was no appreciable difference in the performance of the lubricated and non-lubricated valves.

While the committee does not feel that the scope of its investigation has been sufficiently broad to justify any definite recommendations on discontinuing the application of lubricant to triple valves, it does feel that the subject is of sufficient importance to justify a more thorough investigation than the committee has been able to make.

As a conclusion to its report, the committee presents the following proposed instructions on the inspection, repairs and test of freight brakes, and suggests its adoption as recommended practice.

ANNUAL REPAIRS TO FREIGHT-CAR AIR BRAKES.

INSPECTION.

Cleaning and Lubricating Triple Valves.

The triple valve should be removed from the car for cleaning in the shop, and should be replaced by a triple in good condition. It should be dismantled and all the internal parts, except those with rubber seats and gaskets, cleaned with gasoline, then blown off with compressed air and wiped dry with a cloth.

The slide valve and graduating valve must be removed from the triple-piston and retarded release parts from the body in order that the service ports in the slide valve and other parts may be properly cleaned.

No hard metals should be used to remove gum or dirt or to loosen the piston packing ring in its groove.

The feed groove should be cleaned with a piece of wood, pointed similar to a lead pencil. Bags or cloth should be used

for cleaning purposes, rather than waste, as waste invariably leaves lint on the parts on which it is used.

In removing the emergency valve seat, care must be exercised not to bruise or distort it.

Particular attention should be given the triple-piston packing ring. It should have a neat fit in its groove in the piston, and also in the triple-piston bushing; once removed from the piston, or distorted in any manner, it should be scrapped. The fit of the packing ring in its groove and bushing and the condition of the bushing should be such as to pass the prescribed tests.

The graduating stem should work freely in the guide nut. The graduating spring and the retarded release spring in retarded release triple valves must conform to standard dimensions and be free from corrosion. The thread portion of the graduating stem guide should be coated with oil and graphite before re-applying it to the triple cap.

The triple valve piston and the emergency valve must be tested on centers provided for the purpose to insure them being straight. The emergency valve rubber seat should invariably be renewed unless it can plainly be seen to be in first-class condition, which is seldom the case. A check-valve case having cast-iron seat should be replaced with a case having a brass seat.

The cylinder-cap gasket and check-valve case gasket to be carefully examined and cleaned with a cloth; but should not be scraped. All hard or cracked gaskets to be replaced with new ones.

Standard gaskets as furnished by the air-brake manufacturers should be used. The use of home-made gaskets should be avoided, as the irregular thickness results in leakage and causes triple-piston stem to bend or break.

The tension of the slide-valve spring should be regulated so that its contour will be such as to bring the outer end 1/8-inch higher than the bore of the bushing when the outside end of the spring touches bushing when entering.

Before assembling the parts after cleaning, the castings and ports in the body of the triple valve should be thoroughly blown out with compressed air, and all parts of the triple not elsewhere provided for known to be in good condition.

Lubricate the seat and face of the slide valve and slide-valve graduating valve with high-grade very fine dry graphite, rubbing it onto the surface and the upper portion of the bushing where the slide-valve spring bears, so as to make as much as possible adhere to and fill up the pores of the brass, leaving a very thin coating of free graphite. The parts to be lubricated with graphite must be free from oil or grease.

Rub the graphite in with a flat-pointed stick over the end of which a piece of chamois skin has been glued. At completion of the rubbing operation a few light blows on the slide valve will leave the desired light coating of loose graphite.

The triple-valve piston packing ring and its cylinder should be lubricated with either a light anti-friction oil or a suitable graphite grease as follows:

Apply a light coating to the packing ring and insert the piston and its valves in the body, leaving them in release position, then lubricate the piston-cylinder and move the piston back and forth several times, after which remove the surplus from the outer edge of the cylinder to avoid leaving sufficient lubricant to run on the slide valve or seat while the valve is being handled or stored ready for use.

No lubrication to be applied to the emergency piston, emergency valve or check valve.

All triple valves after being cleaned or repaired must be tested, preferably on a rack conforming to the attached print, and pass the test prescribed under the subject of "Triple Valve Tests" before being placed in service.

Should any of the triple-valve bushings require renewing, such work should be done by the air-brake manufacturers.

Triples in which packing rings are to be renewed, slide valve or graduating valves renewed or faced, if the latter is of slide type, should be sent to a central point or general repair station for repairs.

When applying the triple valve to the auxiliary reservoir, the gasket should be placed on the triple valve, not the reservoir.

CLEANING.

Lubricating and Inspection of the Brake Cylinders.

First, secure the piston rod firmly to the cylinder head, then after removing the non-pressure head, piston rod, piston head and release spring, scrape off all deposits of gum and dirt with a putty knife or its equivalent, and thoroughly clean the removed parts and the interior of the cylinder with waste saturated with kerosene.

Packing leathers must not be soaked in kerosene oil as it destroys the oil filler placed in the leather by the manufacturers, opening the pores of the leather and causing them to become hard.

Particular attention to be paid to cleaning the leakage groove and the auxiliary tube. Triple valve must be removed when the auxiliary tube is being cleaned.

The expanding ring when applied in the packing leather should be a true circle and fit the entire circumference, and have an opening of from 3-16 to 1/4 inch; when removed from the cylinder the ring opening should be 1 1/2 to 1 9-16 inches, and with this opening, of course, will not be a true circle.

A packing leather which is worn more on one side than the other should be replaced with a new one of uniform thickness, or turned so as to bring the thin side away from the bottom of the cylinder. The piston should be turned each time the cylinder is cleaned. In putting a packing leather on piston, it should be so placed as to bring the flesh side of the leather next to the cylinder walls.

Follower studs to be firmly screwed into the piston heads, and nuts to be drawn up tight before replacing the piston.

The inside of the cylinder and packing leather to be lightly coated with a suitable lubricant, using not more than 4 ounces nor less than 3 ounces per cylinder.

Part of the lubricant should be placed on the expander ring, and the adjacent side of the packing leather, thus permitting the air pressure to force the lubricant into the leather at each application of the brake.

No sharp tools should be used in placing the packing leather into the cylinder.

After the piston is entered and before the cylinder head is replaced, the piston rod should be slightly rotated in all directions, about three inches from the center line of the cylinder, in order to be certain that the expanding ring is not out of place.

In forcing the piston to its proper position in the cylinder, the packing leather will skim from the inner walls of the cylinder any surplus lubricant that may have been applied. It has been found good practice to again extract the piston and remove the surplus lubricant.

All stencil marks to be scraped off or painted over with black paint. The place of cleaning, day, month and year to be stenciled with white paint, preferably on both sides of the cylinder or auxiliary reservoir, or if this is not readily visible, in a convenient location near the handle of the release rod.

The bolts and nuts holding the cylinder and reservoir to their respective plates and the latter to the car, to be securely tightened.

The brake cylinder to be tested for leakage after cleaning, preferably with an air gauge, which can be done by attaching the gauge to the exhaust port of the triple valve before connecting the retainer pipe, or where the latest type retainers are used the gauge can be connected to the exhaust port of the retaining valve. In either case, the gauge will indicate cylinder leakage on releasing the triple valve after making an application, and when attached to the retainer valve it will also test the retainer and retaining-valve pipe.

Brake-cylinder leakage should not exceed five pounds per minute, from an initial pressure of fifty pounds.

Each time the triple valve and the brake cylinder are cleaned, the brake pipe, brake-pipe strainer and branch pipe should be thoroughly blown out and the triple valve strainer cleaned before recoupling the branch pipe to the triple valve. If a dirt collector is used, the plug should be removed, the accumulation blown out and the threaded portion of the plug coated with oil and graphite before replacing.

All union gaskets should be made of oil-tanned leather. The use of rubber in unions should not be permitted.

Piston travel should be adjusted to not less than 5 1/2 nor more than 7 inches.

ADDITIONAL INSPECTION AND REPAIRS TO CARS.

When the brake cylinder and triple valve is cleaned, the following additional work should be done to the car:

Retaining valve cleaned by removing the cap, wiping or blowing out all dirt and seeing that the valve and its seat are in good condition, the retaining position exhaust port open and the valve proper is well secured to the car in a vertical position, pipe clamps applied where missing and tightened where loose, hose and angle cocks turned to their proper position. Pipe joints, air hose, release valves, angle and stop cocks should be tested by painting the parts with soap suds while under an air pressure of not less than 70 pounds, preferably 80 pounds, and defective parts repaired or removed.

See that there are no broken or missing brake shoes; brake beams or foundation brake gear, and if the car belongs to a foreign road, a repair card should be made out covering all work that has been done and attached to the car, as per M. C. B. Rules.

The inspection and repairs which have been mentioned should be made to all cars at least once in twelve months.

TRIPLE-VALVE TESTS AND INSTRUCTIONS FOR OPERATING TRIPLE-VALVE TEST RACK.

Mounting Triple Valves for Testing.

With the triple-valve gasket applied to the face of the triple-valve flange, place the latter against the face of the stand in a vertical position and open cock "X," as shown on attached piping diagram, Fig. 3. Connect the brake pipe to the triple, then open cock "Z."

Before attaching triple valves suitable for use with 8-inch brake cylinders, insert in the auxiliary reservoir end of the

valve the friction-increaser extension piece, suitable for the valve under test.

Two triple-valve stand face plates are required for each test rack to permit the testing of all types of freight triple valves.

Plate No. 1 is for use when testing triple valves for 8-inch cylinders.

Plate No. 2 is for triple valves used on 10-inch cylinders.

If it is found necessary to repeat any test which has necessitated a reduction of auxiliary reservoir pressure, valve "B" may be moved to position No. 2, which provides a by-pass around the triple valve from the brake pipe to the auxiliary reservoir, thereby permitting a quick recharge.

Test No. 1.—Charging Test for Triple Valves.

Commencing the tests with cocks 2, 3, 7 and 9 open, all other numbered cocks closed, valve "V" in position No. 3 (lap), valve "A" in position No. 1, auxiliary reservoir empty and main reservoir pressure 80 pounds pressure, proceed as follows:

Close cock No. 7 and open No. 1, and with 80 pounds pressure in the brake pipe note the time required to charge the auxiliary reservoir to specified pressure, as given in the following table:

(Note.—If, during this test or Test No. 2 (LeakageTest), any considerable leakage is discovered, the charging test must be repeated.)

With break-pipe pressure maintained at 80 pounds, the triple valves should charge the auxiliary reservoir as follows:

CHARGING AUXILIARY RESERVOIR.

	From 0 to 30 Lbs. Seconds.		From 0 to 70 Lbs. Seconds.	
Westinghouse Triple Valve	Min.	Max.	Min.	Max.
8-inch non-quick service	21	28	58	78
10-inch non-quick service	13	17	34	44
8-inch quick service	32	42	100	120
10-inch quick service	19	24	60	72
	From 0 to 30 Lbs. Seconds.		From 0 to 70 Lbs. Seconds.	
New York Triple Valve	Min.	Max.	Min.	Max.
8-inch non-quick service	..	..	61	82
10-inch non-quick service	..	..	46	61
8-inch quick service	..	..	100	120
10-inch quick service	..	..	65	80

These tests give practically the same results, and the time of charging from 0 to 30 pounds is given simply to save time in making the test.

Test No. 2.—Leakage Test.

Commencing each of the sections of Test No. 2, with cocks 1, 2, 3 and 9 open, all other numbered cocks closed, valve "B" in position No. 3 (lap), valve "A" in position No. 1, and auxiliary reservoir charged to 80 pounds, proceed as follows:

Sec. "A," Test No. 2.—Westinghouse Triple Valves and New York Quick-service Triple Valves. Leakage at Exhaust in Emergency Check-Valve and Cylinder-Cap Gasket Leakage.

Operate the triple valve two or three times in quick action by closing and opening cock No. 1; finally leaving it closed.

Coat the exhaust port of triple valve with soapsuds to ascertain if leakage exists past the slide valve or bushing to the exhaust with the piston and slide valve in emergency position.

Close cocks 2 and 3 and note the rate of fall of pressure indicated by the brake-cylinder gauge hand, which is now connected only with the small volumes between cocks 2 and 3 and the triple valve. A leakage greater than 5 pounds in 10 seconds indicates either excessive check-valve leakage or that the piston does not seal against the cylinder-cap gasket.

At the completion of this test, open cocks 2 and 3 in the order given.

Sec. "B," Test No. 2.—Leakage at Exhaust in Release Slide Valve of Emergency-valve Leaking.

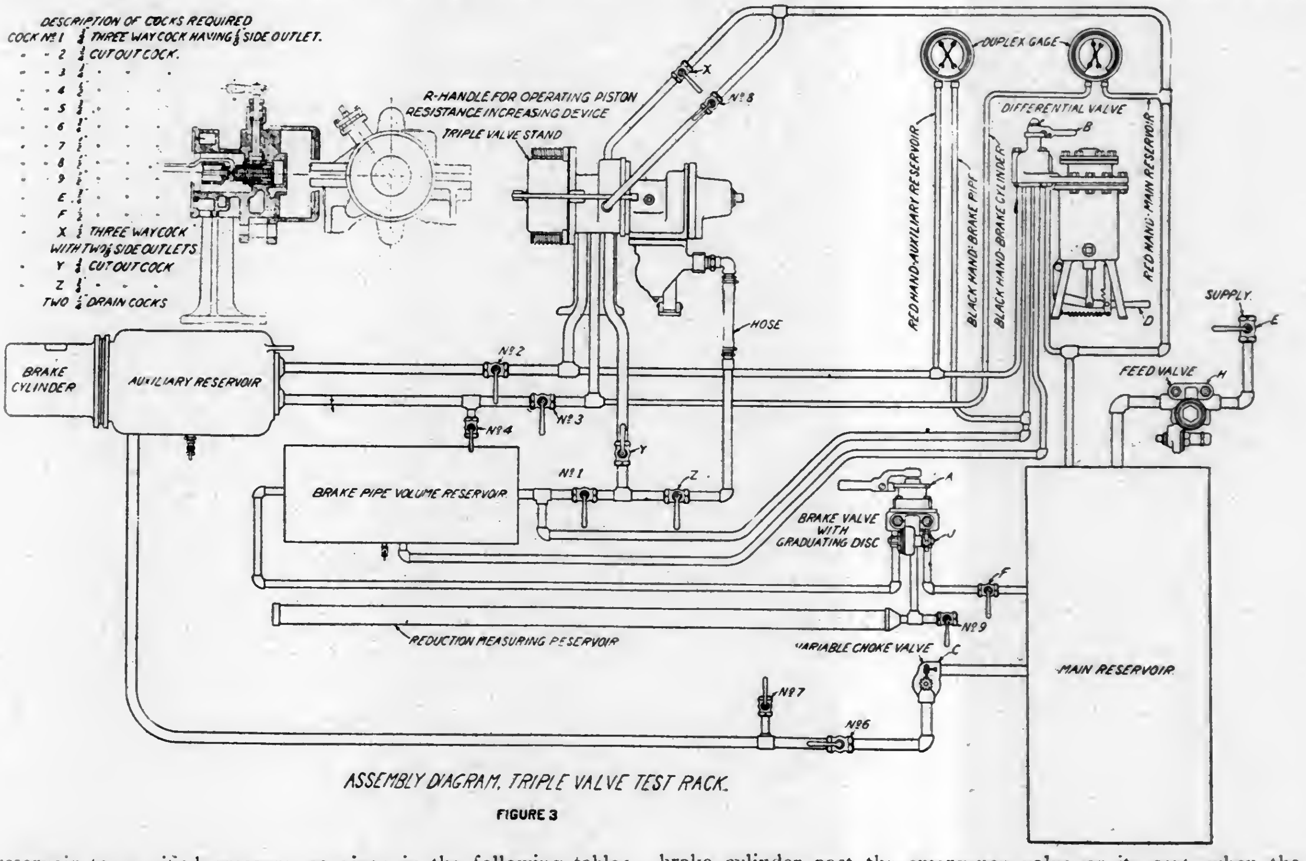
Open cock 1, and after the brake-cylinder pressure is exhausted close cock 3 and again coat the exhaust port with soapsuds to determine if there is any leakage from the auxiliary reservoir to the brake cylinder past the slide valve when the triple valve is in release position, or from the brake pipe to the brake cylinder past the emergency valve or its seat, when the differential on the emergency valve is high. Open cock 3, then paint the body of the triple valve with soapsuds to determine if leakage exists direct to the atmosphere through castings or gaskets.

If leakage is discovered at the triple exhaust in release position, determine if it is from the auxiliary reservoir or brake pipe in the following manner:

Move valve "A" to position No. 8 and open cock 7 until the brake pipe and auxiliary reservoir are empty; then with the valve "J" in position No. 3, place a soap bubble on the exhaust port and place valve "A" in position No. 2. If no leakage is found at the exhaust, advance valve "J" by stages from position to position until a brake-pipe pressure of 10 pounds is obtained. Any leakage from the exhaust while the auxiliary reservoir is without pressure must be from brake pipe, past the emergency valve. Therefore, if no exhaust leakage is found and leakage did exist while the auxiliary reservoir was charged, it indicates defective slide valve. At the completion of this test, close cock No. 7 and move valve "A" to position No. 1, recharging auxiliary reservoir.

Sec. "C," Test No. 2.—Graduating-valve Leakage.

Move valve "A" to position No. 7 until a brake-cylinder pressure of from 20 to 30 pounds is obtained. Then return valve "A" to position No. 3 and close cock 3. If the brake-cylinder pressure then increases without leakage at the exhaust port, it is proper to assume that the graduating valve is leaking, providing it has been determined by the preceding tests that the emergency valve is tight. If leakage at the exhaust occurs during this test, which will be determined by placing a soap bubble on the exhaust, the leakage may be either from



ASSEMBLY DIAGRAM, TRIPLE VALVE TEST RACK.

FIGURE 3

slide valve or graduating valve. The rate of rise of pressure on the brake cylinder gauge, resulting from graduating-valve leakage, must not exceed 5 pounds in 20 seconds. This comparatively rapid rate of rise is permissible owing to the extremely small volume of the section of brake-cylinder pipe into which the leakage is occurring.

At the completion of test, open cock 3 and move valve "A" to position No. 1.

Sec. "A," Test No. 2.—Non-quick Service. New York Triple Valve. Leakage at Exhaust in Emergency. Check-valve, Quick-action Valve and Cylinder-cap Gasket Leakage.

Operate the triple valve two or three times in quick action by closing and opening cock 1, finally leaving it closed.

Coat the exhaust port of triple valve with soapsuds to ascertain if leakage exists past the exhaust valve or bushing, with the piston and slide valve in emergency position. Close cocks 2 and 3. If the brake-cylinder gauge now indicates leakage greater than 5 pounds in 10 seconds the leakage is excessive, and is usually due to imperfect seating of the check valve or quick-action valve, or to the main piston not making a tight joint on the main-cylinder gasket. To locate the defect place soap bubbles on the vent ports. No leakage at these points indicates that the leakage is past the main-cylinder gasket. If leakage is found at the vent ports open cocks 1, 2 and 3 and recharge the auxiliary reservoir to 80 pounds, then move valve "A" to position No. 7 until the brake-pipe pressure is reduced to 10 pounds and return valve "A" to position No. 3. Close cock 2, and if the quick-action valve is leaking the brake will immediately release. If it does not, the leakage is past the check valve.

At the completion of this test, if no leakage were found, open cocks 1, 2 and 3, and if leakage were discovered open cock 2 and move valve "A" to position No. 1.

Sec. "B," Test No. 2.—Exhaust-valve Leakage in Release; also Vent-valve and Quick-action Valve Leakage

Close cock 3 and coat the exhaust port with soapsuds to determine if there is any leakage from the auxiliary reservoir past the exhaust valve, or graduating valve or triples, having this valve tandem with the exhaust valve, when the triple is in release position. If exhaust leakage is found, the triple under test has tandem exhaust and graduating valves, determine which valve is leaking by making graduating-valve leakage test.

Sec. "C," Test No. 2.—Graduating-valve Leakage.

Move valve "A" in position No. 7 until a brake-cylinder pressure of from 20 to 30 pounds is obtained. Then return valve "A" to position No. 3 and close cock 3. If the brake-cylinder pressure then increases without leakage at the exhaust port, it is proper to assume that the graduating valve is leaking. The rate of rise of pressure on the brake-cylinder gauge, resulting from graduating-valve leakage, must not exceed 5 pounds in 20 seconds. This comparatively rapid rise is permissible owing to the extremely small volume of the section of brake-cylinder pipe into which the leakage is occurring.

If leakage at the exhaust occurs during this test, which will be determined by placing a soap bubble on the exhaust, the leakage is by the exhaust valve instead of the graduating valve.

At the completion of the test open cock 3 and move valve "A" to position No. 1.

Test No. 3.—Test for Type "K" Triple Valves for Retarded-Release Feature; for Both Westinghouse and New York Triple Valves.

Commencing the test with cocks 1, 2, 3 and 9 open, all other numbered cocks closed, auxiliary reservoir charged to 80 pounds, valve "B" in position No. 3 (lap), lever "D" in position No. 2 and valve "A" in position No. 3 (lap), proceed as follows:

Move valve "A" to position No. 7 until brake-pipe pressure is reduced 20 pounds, then return it to position No. 3; place valve "J" in position No. 4; valve "B" in position No. 1, and valve "A" in position No. 2. This should move the triple-valve parts to normal (full release) position.

If the triple valve moves to retarded-release position, which is indicated by a contracted exhaust and slow release of brake-cylinder pressure, it indicates a weak or broken retarded release spring, or undue friction in the retarding device.

Following this test, recharge the system to 80 pounds by moving valve "A" to position No. 1 and valve "B" to position No. 2.

When the brake pipe and auxiliary reservoir are charged to 80 pounds move valve "A" to position No. 7 until brake-pipe pressure is reduced 20 pounds, then return it to position No. 3. Place valve "J" in notch No. 8, lever "D" in notch No. 4, valve "B" in position No. 1, and valve "A" in position No. 2.

Under these conditions the triple-valve piston and slide valve should be forced to retarded-release position. If this does not occur it indicates that the retarded-release spring is not standard or the retarding devices have excessive friction. Completing test, place valve "B" in position 3 and valve "A" in position 1.

Sec. "A," Test No. 4.—Application Test for Both Westinghouse and New York Triple Valves.

If for any reason it is desired to make this test following an application and release produced by closing and opening cock 1, or the auxiliary reservoir has just been charged by opening cock 1, this test should be preceded by an application and release with valve "A," for the purpose of insuring the slide valve being in its normal position.

Commencing the test with cocks 1, 2, 3 and 9 open, all other numbered cocks closed, valve "A" in position No. 1, valve "B" in position No. 2, and lever "D" in notch 3, then with the auxiliary reservoir charged to 80 pounds, proceed as follows:

To test triple valves for 8-inch cylinders, place valve "B" in position No. 4 and valve "A" in position No. 5.

To test triple valves for 10-inch cylinder, place valve "B" in position No. 4 and valve "A" in position No. 6.

In all of these tests the triple valve should move to application position without causing a discharge of air from the vent port of valve "B."

A failure to apply under the conditions specified indicates either excessive friction, which will be shown by an exhaust from the vent port of valve "B"; a leaky packing ring, which will be discovered later by the packing-ring leakage test; too large a feed groove in the cylinder, or a combination of two or more of these defects. Should the triple valve fail to apply and no exhaust occur from valve "B," the indications are that the back flow of air from the auxiliary reservoir to the brake pipe is too rapid to permit the required differential.

At the completion of this test move valve "B" to position No. 3 and valve "A" to position No. 1.

Sec. "B."—Quick-service Test (for Quick-service Triple Valves Only) for Both Westinghouse and New York Triple Valves.

Commencing the test with cocks 1, 2, 3 and 9 open, all other numbered cocks closed, valve "A" in position No. 1, valve "B" in position No. 3 and auxiliary reservoir charged to 80 pounds, proceed as follows:

Close cock 9 and move valve "A" to position No. 7 for all 8-inch and 10-inch triple valves. The brake-cylinder pressure obtained should not be less than 5 pounds greater than that which will be obtained by subjecting to the same test triple valves which do not contain the quick-service features.

At the completion of this test move valve "A" to position No. 1 and open cock 9.

Test No. 5.—Packing-ring Leakage Test for Both Westinghouse and New York Triples.

Release Test, Sec. 1.—Commencing with cocks 1, 2, 3 and 9 open, all other numbered cocks closed, valve "A" in position No. 1, valve "B" in position No. 3, and the auxiliary reservoir charged to 80 pounds, proceed as follows:

Place the valve "A" in position No. 7 until the brake-pipe pressure is reduced 15 pounds, then return to position No. 3 (lap). Place valve "J" in position No. 2, lever "D" in notch No. 1, and valve "B" in position No. 1; close cocks 2 and 3 and move valve "A" to position No. 2. If the discharge does not occur promptly from the vent port of valve "B," advance valve "J" from position to position until the discharge begins, then note the rate of increase of pressure on the auxiliary reservoir gauge, which must not exceed 5 pounds in 30 seconds.

During this test there must be a steady exhaust of air from the vent port of valve "B" to insure the proper differential being maintained on the triple-valve piston. If, in making this test, the triple valve for the 8-inch cylinder releases or indicates excessive ring leakage, make another test, beginning with moving handle "R" to the right, after making the proper brake-pipe reduction and before starting to increase the brake-pipe pressure. Immediately after the test is completed, handle "R" should return to its normal left position.

Should it occur that the friction of the triple valves for the 10-inch brake cylinder is so low as to continue to permit the triple to release, the reduction for the application may be changed from 15 to 10 pounds. When this is done, special attention should be given to determining if the graduating valve is right, as it must be, to permit an accurate test.

At the completion of this test place valve "B" in position No. 3, open cocks 2 and 3 and place valve "A" in position No. 1.

Test No. 6, Sec. 2.—Friction Test. Release Test for Both Westinghouse and New York Valves.

Commencing the test with cocks 1, 2, 3 and 9 open and all other numbered cocks closed, valve "A" in position No. 1, valve "B" in position No. 3, auxiliary reservoir charged to 80 pounds.

Place lever "D" in notch 3 for all triple valves undergoing the test; proceed as follows:

Place valve "A" in position No. 7 until the brake-pipe pressure is reduced to 10 pounds, then return it to position No. 3. Place valve "J" in position No. 1, valve "B" in position No. 1, and move valve "A" to position No. 2. Under these conditions the triple valve should release. A failure to release should be accompanied by a discharge at the vent port of valve "B," which indicates that the frictional resistance to the movement of the packing ring and slide valve is excessive.

If the triple valve does not release and valve "B" fails to open its exhaust, leakage is occurring from the brake pipe, which will necessitate advancing valve "J" from position to position, remaining in each position 30 seconds, until the triple valve releases or the exhaust in valve "B" opens.

At the completion of the test place valve "B" in position No. 3 and valve "A" in position No. 1.

Test No. 7, Sec. "A."—Service-port Capacity Test for Westinghouse Triple Valves and Quick-service New York Triple Valves.

Commencing with cocks 1, 2, 3, 4 and 9 open, valve "A" in position No. 1, valve "B" in position No. 3, place valve "C" in position required for the triple valve under test, as indicated:

Notch No. 1.—For 8-inch triple valves.

Notch No. 2.—For 10-inch triple valves

During this test the brake-pipe pressure should not drop, except that in the case of the quick-service triple valves there will, of necessity, be a slight drop, which must not exceed 2 pounds.

Place valve "B" in position No. 2 and move valve "A" to position No. 3, open cock 7 until brake-pipe and auxiliary-reservoir pressures are reduced to 50 pounds, then close cock 7. Move valve "B" to position No. 3 and open combination cock 6 and quick-opening valve, leaving it open 3 seconds. This test should not produce quick action. If it does, it indicates a restriction in the service port, or a weak or graduating spring.

SEC. B.—Duplicate the tests specified under Sec. A, placing the wheel of valve "C" in the position as indicated.

Notch No. 3.—For 8-inch triple valves.

Notch No. 5.—For 10-inch triple valves, excepting Westinghouse non-quick service, with which use notch 7.

This should result in the triple valve moving to emergency position. Failure to do so indicates too close a fit of the emergency piston.

At the completion of the test close cock 4 and combination cock 6 and quick-opening valve, move valve "A" to position No. 1.

Test No. 7, Sec. "A."—Service-port Capacity Test for New York Non-quick Service Triple Valves.

Commencing with cocks 1, 2, 3, 4 and 9 open, valve "A" in position No. 1, valve "B" in position No. 3, place valve "C" in position required for the triple valve under test, as indicated.

Notch No. 1.—for 8-inch triple valves.

Notch No. 2.—For 10-inch triple valves.

Place valve "B" in position No. 2 and move valve "A" to position No. 3. Open cock 7 until brake pipe and auxiliary reservoir pressure are reduced to 50 pounds, then move valve "B" to position No. 3 and open cock 6 quickly.

NOTE.—During this test the triple valve should move to service position, the brake-pipe pressure must not drop and there must be no discharge of air from the vent ports.

Should the triple valve move to emergency position, it indicates a restriction in the service ports or a weak vent-valve spring.

SEC. B.—Duplicate the test specified under Sec. A, placing the wheel of valve C in the position as indicated for the triple valve under test.

Notch No. 3.—For 8-inch triple valves.

Notch No. 5.—For 10-inch triple valves.

This should result in the triple valve moving to emergency position, causing a strong blast of air from the vent ports and a brake-pipe reduction of at least 3 pounds. Failure to do so indicates a too loose fit of the vent-valve piston packing.

AIR-BRAKE HOSE COUPLINGS.

PART I.

Air-brake Hose Couplings and Packing Rings.

In its investigations the committtee assumed that all air-brake hose couplings and packing rings now in use were supplied by the Westinghouse Air Brake Company and the New York Air Brake Company, or in accordance with their standard dimensions, and therefore the question of the best possible interchange of proposed standard and existing couplings and rings has received due consideration.

For the purpose of determining whether there are sufficient variations in the dimensions of various makes of couplings to justify the Association in adopting a standard with a view of securing a more satisfactory interchange, more than five thousand new and used couplings have been gauged and tested. This investigation revealed the fact that the dimensions of couplings which should be common to all makes vary appreciably in couplings supplied by different manufacturers.

Enlarged drawings have also been made showing the variation in the principal dimensions employed by the Westinghouse Air Brake Company and the New York Air Brake Company in the design of their respective coupling and packing ring. Outlines of the former and details of the latter are shown in Fig. 4 (not reproduced), from which it will be seen that there is a difference of 1-64 inch in the nominal height of a Westinghouse and a New York packing ring. Also, there is 3-64 inch difference in one of the principal dimensions of the couplings affecting the compression of the rings.

When two Westinghouse couplings, with Westinghouse packing ring in each, are coupled together, the nominal compression of each packing ring is 3-128 inch. When the couplings are pulled apart (as is the case when cars are uncoupled without first parting the hose) the faces of the hose couplings are 1-32 inch apart.

With two New York couplings, having a New York packing ring in each, coupled together, the compression of each ring is nominally 1-32 inch; and when the couplings are pulled apart, the space between the faces of the couplings is only 1-64 inch.

If Westinghouse packing rings are used in New York couplings, the compression of each ring will be 3-64 inch, or 1-64 inch greater than when New York packing rings are used in New York couplings. A combination of New York packing rings and Westinghouse couplings will reduce the nominal compression of the latter to 1-128 inch.

The permissible variation in the nominal compression of the rings, with the existing standards of the air-brake manufacturers, is therefore in the ratio of 6 to 1, or 600 per cent., which, in the judgment of the committee, justifies the Association in considering the adoption as standard, or recommended practice, such dimensions relating to air-brake hose couplings and packing rings as will insure greater protection against leakage and lessen the damage to hose when "pulled apart" than is now possible.

NEW PROPOSED STANDARD COUPLING.

Fig. 5 shows the detail drawing, as submitted by the Air-hose Committee in 1909, revised.

The revision consists of an outline of the reinforced guard arm, a 1-16 inch radius at the back of the groove for the packing ring, and of a second (3-16-inch and 5-32-inch) radius in the groove of the guard arm and at the outer lug, to provide suitable clearance at point "B."

For convenient reference, the packing ring as recommended in 1909 is also shown in detail in Fig. 5.

Leakage at the packing ring and damage to hose when "pulled apart" will depend largely upon the permissible variation in nominal dimensions to meet manufacturers' requirements.

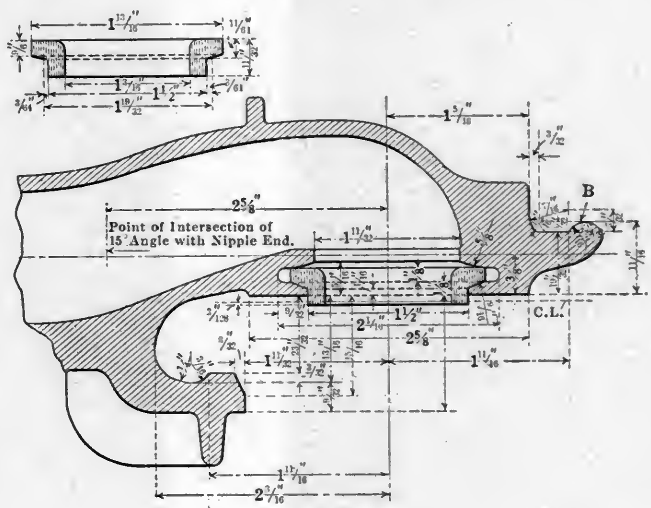


FIG. 5.

The question of maximum variation in nominal dimensions affecting the compression of the ring and the clearance between faces of coupling has therefore been thoroughly investigated by (as previously stated) "gauging and testing over five thousand couplings" and a number of packing rings. Couplings which were found to slightly vary from the manufacturer's standard were tested under air pressure on a pulling machine, with which could be approximated the strains to which the hose is subjected in service through the slack action and curving of cars. Notwithstanding the fact that no tests were made with frozen hose (which is, perhaps, the severest service test for ring leakage that can be made), the investigation leads to the conclusion that the air-brake manufacturers can be depended upon to supply their hose couplings and rings with a degree of accuracy that will insure satisfactory service.

This conclusion does not apply, however, to packing rings secured in the open market. In gauging and testing a large number of sample packing rings which were supplied by various rubber companies, less than ten per cent. of them were found to be fit for service. A number of these sample rings were represented by the rubber manufacturers to be "M. C. B. Standard," "perfect samples," etc.

If the members of the Association care to consider securing packing rings in the open market, then suitable minimum and maximum gauges for them should first be adopted (consideration of which does not come within the scope of the committee's investigation on couplings and rings).

It has been suggested that the Association should adopt minimum and maximum dimensions for the couplings as a whole.

This would affect further developments in the device, such as are now being made by the two leading air-brake companies in what may be termed a "hose-protector coupling," with which it is intended to minimize the tension in the hose when pulled apart. The committee has therefore confined its recommendations to nominal dimensions affecting the interchange of couplings and rings.

Summary.

Summarizing, it can be said that two couplings and packing rings conforming to the dimensions shown in Fig. 5 will couple together as satisfactorily and with equal assurance against leakage at the packing ring, and with as little damage to hose when pulled apart, as is now had with couplings and rings conforming to the standards of the Westinghouse Air Brake Company.

One of the proposed M. C. B. couplings and rings, as shown in Fig. 5, will interchange with couplings and rings conforming to the standard of the New York Air Brake Company more satisfactorily and with greater assurance against leakage and damage to hose when pulled apart than is now possible with a Westinghouse and New York coupling coupled together.

A proposed M. C. B. coupling and packing ring (as shown in Fig. 5) and a Westinghouse coupling and packing ring will interchange at satisfactorily and with equal assurance against leakage and damage to hose when pulled apart as will two couplings conforming to the standard of the Westinghouse Air Brake Company.

Part II.

Gauges for Air-brake Hose Couplings.

The question of gauges for used air-brake hose couplings has been investigated with the view of determining proper contour lines of the gauges. A number of used couplings have been gauged (and subsequently tested) with gauges of such proportions and dimensions as to provide for condemning couplings with guard arms and lugs distorted or worn from 1-128 inch to 1-32 inch.

The committee does not feel justified in suggesting the adoption of the proposed dimensions without first gauging (with the proposed gauges) a sufficient number of couplings to confirm the committee's judgment in the premises. The committee therefore desires to report "progress" on the question of gauges for air-hose couplings and respectfully asks for further time in which to complete its investigation.

Discussion.—Some objection was raised to the recommendation of wiring the defect card on to the car instead of tacking it up in an exposed place. It was explained by the committee that this matter had been given very careful attention and it was decided that to have it wired on was better practice.

F. W. Brazier (N. Y. C.) drew attention to the inferior gaskets which a number of roads are applying and recommended that all gaskets found which were not absolutely standard be thrown into the scrap heap.

Considerable discussion was raised in connection with the two-hole connection in the truck lever connection. The consensus of opinion seemed to be that more holes should be shown on this drawing, and a motion was finally carried that it should be revised to show three holes at each end.

W. F. Bentley (B. & O.) recommended that the word "preferable" be eliminated from the section of the report that referred to the matter of testing triple valves on the test rack after cleaning or repairing. Mr. Burton drew attention to the fact that this is recommended practice in any case, and would not be binding even without the word "preferable."

A motion was carried that the recommendations of the committee, as to the defect card, the bottom rod, the annual repairs to freight car brakes and the adoption of a hose coupling and packing ring be referred to letter ballot for adoption as recommended practice.

RULES FOR LOADING MATERIAL

Committee:—A. Kearney, chairman; R. E. Smith, Wm. Moir, W. F. Kiesel, L. H. Turner.

The committee reports it has no recommendations for changes in the present Rules for Loading Material to present to this convention, except to correct some errors, for the most part typographical, that were made in the last issue of the rules.

This conclusion has been reached as the result of the few subjects for change that have been presented during the current year, and more especially in order to give every one handling the rules more time and better opportunity to make up their minds what changes are really necessary.

First of all, we would direct your attention to Rule 26 of the 1910 Revision of the Rules for Loading Material.

In the 1910 issue Rule 26 provides for the exclusive use of metal spacing blocks. Probably everybody will recall the discussion of this point on the floor of the convention last year, and the action taken at that time, to eliminate that modification requiring metal blocks exclusively. It was decided then to continue the use of Rule 26 in its old form, that is, making the use of metal or wooden blocks optional.

It was a mistake allowing Rule 26 to go into the new issue of the rules in its modified form. The rule should read;

"The cars must be jacked apart by placing one jack on each side of the coupler, separating the cars until the couplers are pulled out to the fullest extent, inserting hardwood or metal blocks (latter preferred) to completely fill the space between the horns of coupler and end of sill, and coupler release-rod chain disconnected, as shown in Figs. 2 and 3."

Discussion.—The chairman stated that rule 6 was in conflict with A. R. A. rule 15, but believed that after further investigation the committee could alter it to make them harmonize without altering the principle.

Metal or wood spacing blocks were again under discussion, and a motion was passed eliminating the word "preferred" after the word "metal" in the rule, thus allowing either block to be used. Rule 121 was referred to letter ballot.

The report of the committe was accepted and referred to letter ballot.

CONCLUDING EXERCISES

While awaiting the report of the tellers on the election, the meeting was thrown open for general discussion on any subject and the matter of the present method of election was brought up by D. F. Crawford, who moved that the executive committee be authorized to appoint a committee with a view of simplyifying it and to transmit a circular report to the members before December 1, which should give the necessary changes in the constitution to be voted upon next year. This motion was carried.

Apprentices in the car shop was discussed, and a motion was carried to the effect that a special committee be appointed to report next year on this subject.

Following this a number of members spoke most strongly on the lateness of the reports this year, and every one, from members to the executive committee, except the secretary, was criticized. It appeared that the blame was not confined to any one point. A motion was finally carried that the appointment of the committee be issued to the members in circular form by the secretary as soon as they were appointed. In this way the members would know what subjects were to be investigated and to whom they might transmit information which came to their attention, and not have to await the receipt of a circular letter.

A motion was carried that the executive committee of the association extend to the executive committee of the American Railway Association a cordial invitation to visit the next convention individually, and the suggestion of the advisability of appointing a committee to visit the convention and make a report upon their observations.

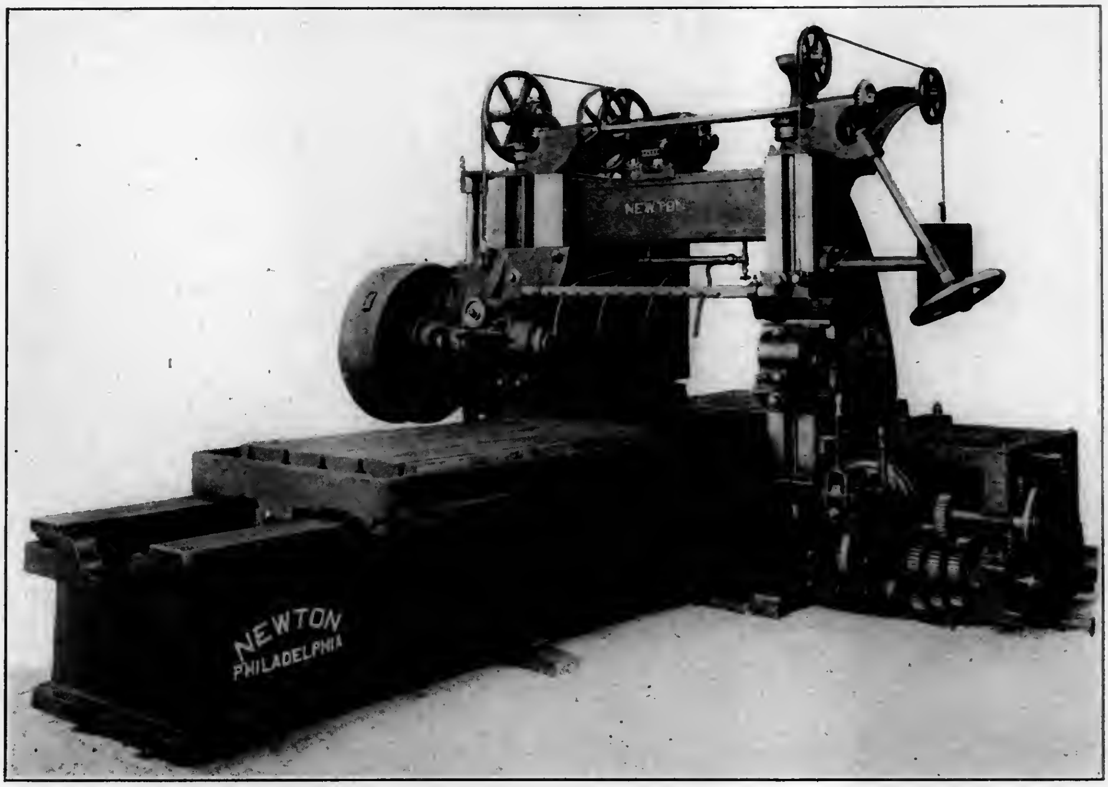
[The reports and discussions on the following subjects will appear in the August issue: Train Pipe and Connection for Steam Heat; Refrigerator Cars; Prices for Labor and Material for Steel Cars; Train Lighting; Car Wheels; Test of Brake Shoes, Revision of Rules of Interchange and Consolidation.—Ed.]

A Flight of Stairs Has Been Erected in Paris over which 14,000,000 persons have passed without so much as scratching the surface. These steps are almost imperishable, for in the concrete of which they are constructed a generous proportion of carborundum has been introduced, and since carborundum is almost as hard as the diamond, it has given the concrete a wearing quality which no marble or granite could possibly approach.

HIGHLY DEVELOPED HORIZONTAL MILLING MACHINE OF UNUSUAL PROPORTIONS

The type of machine herein illustrated has been attempted before, but it is believed that never before have such massive proportions and refinements been incorporated in any similar design. As this heavy 50 in. horizontal milling machine has been in operation but a short time, the Newton Machine Tool Works, of Philadelphia, Pa., have no data available concerning its output, but it is recalled that on their old design of nearly the same proportions and drive locomotive rods have been milled at a feed or table advance of about 8 in. per minute when taking cuts from 3/8 in. to 1/2 in. deep, and from 14 to 18 in. wide. In channeling two rods at one time, each channel 3½ in. wide

A study of the spindle, its drive and accompanying details is of interest as an indication of the care observed in the design to prevent the transmission of vibrations to the cut. The diameter of the spindle in parallel bearing is 7 in., in addition to which there is a double taper bearing in front of the spindle sleeve, the largest diameter of which is 11 in. The spindle sleeve is 13½ in. in diameter and it has 10 in. of independent horizontal hand adjustments. The maximum distance between the spindle saddle and the outboard bearing is 51 in.; minimum distance center of spindle to top of work table, 5 in., and the maximum distance is 31 in. The spindle is arranged to drive a 4 in. diameter cutter arbor by means of a broad face key; it is fitted with a No. 7 Morse taper, and provided with a through retaining bolt to hold the arbors in place, thus relieving the outboard bearing of all strain when taking cuts.



HEAVY DESIGN 50-IN. HORIZONTAL MILLING MACHINE.

and 1¾ in. deep, the table advance, or feed, was 2½ in. per minute.

From these two examples it will be noted that the rating of the machine by pounds of metal removed for a given time, or the number of cubic inches of metal removed, may be erroneous and very misleading, as the stress under which machines operate when taking very deep cuts is much greater than when taking slabbing cuts of even greater sectional area. The conclusion reached by the builders of this tool is that for ordinary slab milling the correct output of machines appears to be about one cubic inch of metal a minute per horsepower.

It is, of course, evident that such heavy duty must require an unusual combination of strength and rigidity, and a study of the design of this machine will clearly indicate that this has been attained in the very highest degree. This is particularly noticeable in the proportions and assemblage of the bed, uprights and cross-rail, which although of the ample stock necessary in machines of this desciption to withstand the severe strains to which they are subjected, have still been so pleasingly fashioned that the general appearance affords little indication of the total weight. Nevertheless the latter is 38,000 lbs. net and the floor space occupied is 21 by 15 ft., thus rendering the machine the largest of its type to be carried regularly as a stock product.

The drive is by a sleeve worm wheel 35½ in. O. D., and it is transmitted by a double keyway. The worm wheel has a bronze ring with teeth of steep lead, and the driving worm is of hardened steel with roller thrust bearings, the latter being cast solid with the spindle saddle. It will be readily appreciated that through this general arrangement all stresses must be contained within the saddle and all vibration at the cut not merely minimized, but effectually eradicated. The drive to the spindle is further through bevel and spur gears connecting with the General Electric Company CLC 62 H.P. intermittent motor for 220 volts circuit, having a speed of 560 to 1,120 r. p. m., which gives a speed range to the spindle of 15.55 to 31.11 r. p. m.

The saddle, which has a bearing on the main upright 24 in. wide by 45 in. long, is counterweighted, and has square lock gibbed bearings on the upright, adjustments being made by taper shoes. The location of this taper shoe is of particular interest, as it is arranged to permit of easy detachment of the saddle should any accidents occur, and also to have the tension on the solid surface. The elevating screws for both the saddle and outboard bearing have a top and bottom bearing to permit of them being maintained in alignment at all times. The adjustment of the spindle sleeve is controlled by a worm and worm wheel, which governs the movement of the rack pinion

engaging into the spindle sleeve. The outboard bearing has an independent horizontal adjustment in its saddle of 8 in.

Among the refinements which have been incorporated in the new machine one which may be prominently mentioned is in connection with the vertical driving spline shaft. This shaft slides through bushings to which it is keyed, causing their rotaton in unison, thus lengthening the life of the bearing by preventing the escape of oil that would occur should the spline shaft rotate in the fixed bearings. The bevel driving gear on the vertical shaft is placed above the driving bevel gear on the horizontal shaft in order that the thrust on the bottom bearing may be equalized by the pressure of the gear and thus eliminate excessive wear on the thrust washers placed at the bottom of the shaft. In the pull pin feed gear bronze centers have been placed to facilitate renewals, if necessary, at a slight cost, and to overcome the objection of having a loose steel gear revolving on a steel shaft. The male friction clutch is fitted with apple wood blocks, thoroughly fitted, and held in place by bolts, a more adequate arrangement than in the former practice, which consisted of blocks and glue.

The feed is taken from the vertical driving shaft through to the operating side of the machine, where there are provided three changes of gear feed ranging from .10, .15 and .20 in. per revolution of the spindle, and there is also provided reversing power fast traverse by means of a friction clutch by engaging the double train of bevel friction clutch gears. One lever engages the clutch controlling the fast traverse of the table, and the direction of movement indicates the direction of travel to the table. Another lever engages the clutch for the transmission of feeds. One hand wheel, as shown, is for the hand movement of the table and the other for the simultaneous adjustment of the spindle saddle and the outboard bearing, which can also be elevated or lowered by means of the independent General Electric Company CQ 3 H. P. series wound 220 volt motor, having a speed of 1,425 r.p.m., which moves the saddle at 6 ft. per minute.

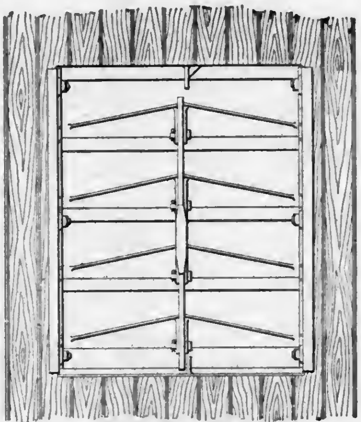
The work table of this machine is 42 in. wide, 14 ft. long, and entirely surrounded by an oil pan. The bed is 21 ft. long and 38 in. over the shear. All gears, with the exception of the worm wheel by which the fast traverse is obtained, are of hammered steel, with the teeth cut from the solid. The machine, viewed in entirety, represents a remarkable development in this extremely important tool, and one indeed which implies that little further could be done to enhance its intrinsic merit.

THE ALLEN CAR VENTILATOR

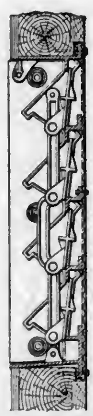
The ventilator now generally in use comprises a grating in the end of the freight car, with a wooden frame, vertical wrought iron rods and wire netting. This ventilator is closed by means of a wooden door sliding on a wrought iron track and secured in closed position by metal guides at the bottom of the door, and a set of ordinary door fasteners.

Certain recognized objections to this style of ventilator, such as high cost of maintenance, liability to damage from shifting loads, and interference of the door with the location of the brake step, have resulted in an entirely new design of car ventilator which has been patented by G. L. Allen, chief draftsman of the Atlanta Coast Line, and is now being applied to 1,400 cars in course of construction for that system by the American Car and Foundry Company.

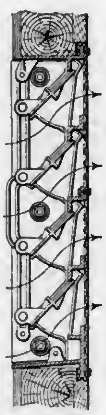
The Allan ventilator, as shown in the accompanying drawing, is very simple in construction, and is composed throughout of malleable iron. In general appearance it is extremely neat, being contained practically within the thickness of the end wall of the car, and occupying a space therein of only about two feet. The essential features of the ventilator are: a main frame having flanges inside of the car on all four sides; "Z"-shaped horizontal bars cast integral with the frame which lap over the top of the movable plates, strengthen the frame transversely and back up the wire netting and movable plates, pivotally connected at the middle by an operating rod. The movable plates are not hinged or pivoted to the frame, but merely rest at their ends in recesses in the sides of the frame. The ventilator is held in an open or closed position by gravity, and needs only to be pulled open or pushed closed, by in each case exerting a slight lifting force on the handle. The holes which are shown in the ends of the operating rod, with corresponding holes in the lugs at the top and bottom of the frame, are provided simply for "sealing."



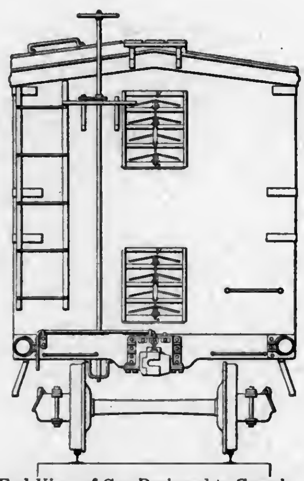
Outside View showing Ventilator Closed.



Sectional View showing Ventilator Closed.



Sectional View showing Ventilator Open.



End View of Car Designed to Comply with Recent Safety Appliance Law.

CONSTRUCTIVE DETAILS AND APPLICATION OF THE ALLEN CAR VENTILATOR

The movable plates, when in open position, stand at an angle of 45 degrees, their long edges in line with the upper edges of the Z-bars below them, thus making it necessary for rain to be driven upward in order to enter the ventilator. The latter is therefore practically rain proof whether open or closed and the slanting plates also tend to deflect sparks. The ease with which the ventilator can be operated makes it possible for train men to manipulate them while the train is in motion. This is an advantage in the case of through trains where the trainmen may pass from one car to another and from the running board or roof of an adjoining car, and open or close the ventilator by means of a rod with a hooked end. The netting is applied on the inside as usual, being crimped over the ventilator flanges on

all four edges and held securely in place by nails or bolts through the flanges and netting.

The Allen ventilator does not interfere with any form of end bracing, whether horizontal or vertical, and being constructed of metal throughout is well adapted for use on cars of all-steel or composite design.

NUT LOCKS VS. DOUBLE NUTTING AND IMPROVEMENTS IN NUT LOCKING PRACTICE

The Jones Positive Nut Lock in the three principal forms in which it is manufactured, is one of the oldest plate form of nut lock on the market. The present owners, who purchased the Jones interests some years ago, made several improvements in

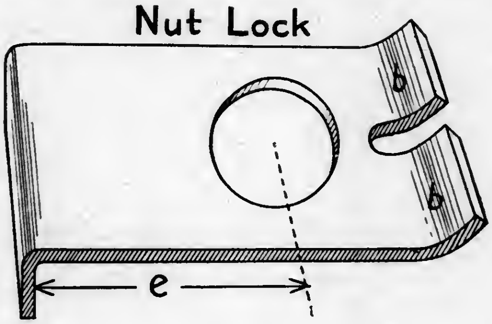


FIG. 1.

the construction of the device, principal among which is the band across the two flanges or slotted end of the arch bar style nut lock as designated by letters "b b" in Figure 1.

This band, made in the process of manufacture, does not interfere with the free sweep of the nut when it is being tightened up, and materially facilitates the application of this device by making it easy to drive one, or both, of the lips "b b" down against the side of the nut with a hammer and without the use of a chisel or special tool.

Another improvement made in connection with the arch bar style is the simple device for fastening column and journal bolts, to lock them and prevent them from backing out of the nuts. This device is manufactured with a flange at each end; one flange to extend down the edge of the arch bar and another flange at the other end to bear against the bolt head. These two flanges at right angles with the body of the fastener, both being made in the process of manufacture, render it unnecessary to do any driving or forming in applying this device other than would be necessary in applying a common wrought washer. This device saves much labor and is meeting with popular favor.

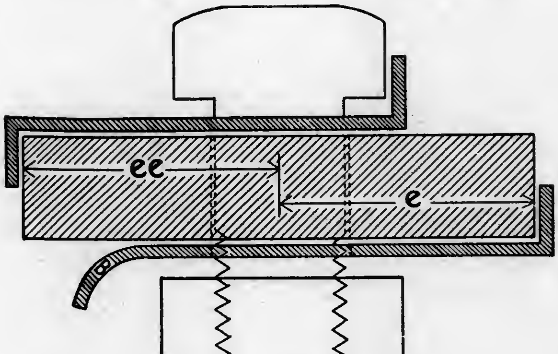


FIG. 2.

Figure 2 shows the application of both the bolt fastener and arch bar style nut lock above mentioned.

The original form of Jones spur nut lock for use on wood surfaces, was made with four beveled spurs, which caused the lock to adhere to the wood securely, even in case of shrinkage. This original form is, however, being gradually superseded by

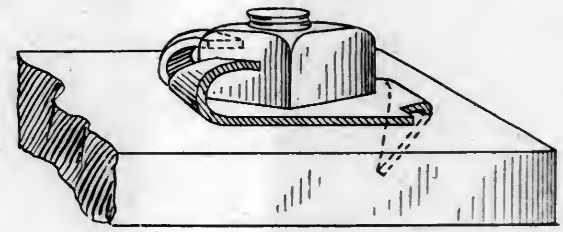


FIG. 3.

the improved form of spur nut lock in the form as shown in Figure 3, which latter form has but one spur or tang to engage the wood surface, which single spur is so located as to come sufficiently within the sweep of the nut to be readily forced into the wood by the ordinary application of the nut without distorting the nut lock. This improved form of spur nut lock is made of much heavier and much wider material than the original form, it having bearing proportions sufficient to afford the nut ample resistance against being drawn into the wood, the same as the recognized proportions of a common wrought washer.

The Jones Two Hole Nut Lock, which has been extensively used on draftrigging bolts, cylinder-block bolts and similar bolts located uniformly a certain distance apart and in other cases where it is inconvenient to extend the nut lock over an angle to secure its bearing is another form of their device which has been improved upon by the circular bend across the two flanges, or slotted end, made in the process of manufacture, as shown in Figure 4, which bend turns down the ends far enough to permit driving them against the side of the nut with a hammer and without the use of a special tool.

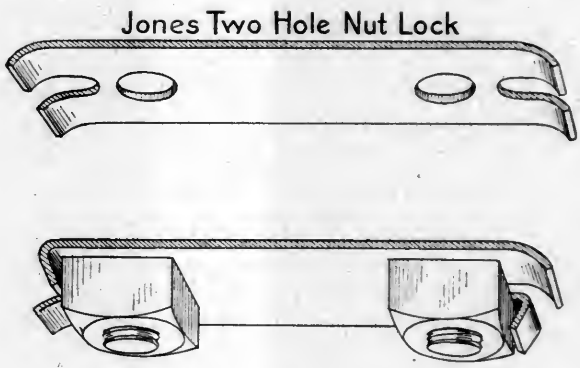


FIG. 4.

Regarding the long established practice of double nutting on many bolts, journal and column bolts particularly, attention is called to the effect produced by the use of a double nut, or jam nut. The use of a single nut applied in the ordinary way brings nut pressure on the upper side, or backside, of the bolt thread, as indicated by letter "B" in Fig. 5. Assuming the first nut to be applied in a proper manner, the bearing of such nut would be against the upper or backside of bolt threads, the same as in previous illustration. However, when jam nut is applied such jam nut in order to be effective must be screwed up with considerable tension against the first nut. As the amount of tension against the under nut depends entirely upon the intelligence of the operative applying it, and no fixed rule is known for correctly measuring such tension and determining the proper amount, depending upon "feel" is perforce guesswork.

If too much tension is exerted on the under nut "X" by screwing the jam nut "J" against it tighter than is necessary to produce the simple locking effect desired, the result is an undue strain or reverse bearing "RB" by the first nut "X" against the bolt threads. In any event, after the best possible application of

a jam nut, the jam nut carries all the load pressure, together with locking strain and the under nut "N" no longer carries any of the load "W," but becomes essentially the same as one of a

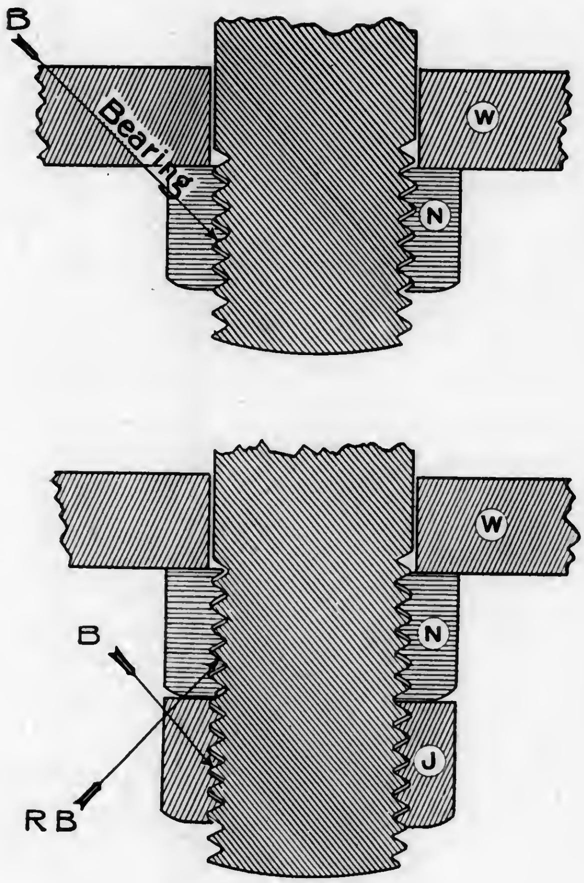


FIG. 5.

number of assembled parts held together by nut pressure, except in so far as its reverse pressure may have established a locking effect upon the outer nut or jam nut "J."

These improvements are used on all the nut locks manufactured by the present owners, the Jones Positive Nut Lock Company, Chicago, Ill.

OPEN SIDE PLANER OF MASSIVE DESIGN

The machine illustrated in the accompanying photograph was recently furnished the Pennsylvania Steel Company by the Cleveland Planer Works, of Cleveland, O., and is a very interesting example of what can be obtained through the combination of great strength and rigidity with extreme simplicity and ease of manipulation.

The machine, which is the builders' standard type parallel drive 60 in. by 60 in. by 22 ft., and equipped for motor installation, is of box section design throughout, in bed, column and cross rail. The bed is cast closed on top, with but one opening sufficient only to admit of the removal of the bull gear. It is ribbed vertically at intervals of about 36 inches for its entire length. The column base is cast integral with the bed, with the bottom cast closed in the column base and the section of the bed directly opposite to it, thus lending materially to the stiffness of the tool. The column is double ribbed vertically on the inside, and of extremely heavy pattern, with a broad bearing on its face, giving ample support to the knee, and is broader than the planing width of the machine. The table is of very heavy pattern, with 5 planed "T" slots, and on each side of every slot is a row of holes, not bored through the table, thus making it impossible for chips to work down to the top of the bed, and thus reducing the liability of injury to the bull gear to a minimum.

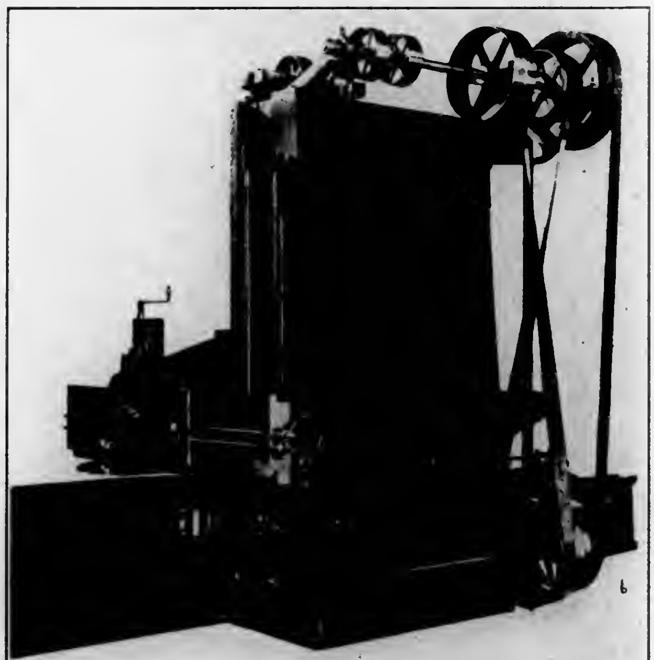
The most important feature in the construction of this machine is its extreme simplicity, as will be readily seen by the illustration, and particularly that there is almost an entire absence of connecting links and arms. All gearing and running shafts can be removed from the sides of this machine without disturbing in any way the column or knee, a feature which will be readily appreciated by mechanics in general. All gears in the drive with the exception of the full gear and its pinion are enclosed and run in oil, making it impossible for chips to damage the working parts.

Both heads are taper gibbed and of ample proportion to insure extreme rigidity to the cut. The heavy bearings are of bronze pressed into bosses cast integral with the bed, thus making it possible to replace these at any time when it might be necessary on account of wear, without changing in any way the alignment of the machine. The feeds are operated by the common type of friction box and are capable of very easy and quick adjustment.

The countershaft, as will be noted, is mounted upon the top of the column and is very firmly supported by three heavy arms, thus giving it necessary rigidity to insure smooth running. The arrangement for supporting the motor is very simple, but effective, as by lowering the entire motor bracket by the adjusting screw immediately beneath, the driving belt from the motor to the countershaft can always be kept at exactly the right working tension.

The approximate weight of this planer is 70,000 pounds, from which it may be judged to be a very substantial and solid tool.

The University of Illinois will receive from the Legislature, recently adjourned, for its support for the two years following July 1, 1911, the sum of $3,500,000. Something more than a half million dollars of this amount is for buildings. The College of Engineering, the success of which interests many of our readers, received specific appropriations for maintenance amounting to $192,000, and for a building $200,000. In addition to this the Department of Mining Engineering received an appropriation for maintenance amounting to $35,000, and for equipment $25,000.



THE CLEVELAND GAP PLANER.

The Legislature in providing for the future support of the University has authorized a one mill tax upon the assessed value of the State.

PERSONALS

C. C. FRALICH has been appointed assistant master mechanic of the Ann Arbor Railroad, with office at Owosso, Mich.

J. E. MEHANEY has been appointed general storekeeper of the First district of the Oregon-Washington Railroad & Navigation Co., with office at Portland, Ore.

C. W. DOWNS, general foreman of the Chicago, Terre Haute & Southeastern R. R. at Terre Haute, Ind., has been transferred to Bedford, with the same company.

T. H. CURTIS, superintendent of machinery of Louisville and Nashville Ry. for the last eight years, has resigned, and will leave railroad work to engage in private business.

C. H. RAE, general master mechanic of the Louisville & Nashville Ry., at Louisville, Ky., has been appointed assistant superintendent of machinery, succeeding Charles F. Giles, promoted.

J. E. OSMER, assistant master mechanic of the Chicago and North Western Ry. at Boone, Iowa, has been appointed master mechanic of the newly created West Iowa division, with office at Boone.

W. A. STEARNS, mechanical engineer of the Louisville & Nashville Ry., at Louisville, Ky., has resigned to become assistant to the chief mechanical engineer of the American Steel Foundries, at St. Louis, Mo.

A. W. MUNSTER has been appointed engineer of tests of the New York, New Haven and Hartford R. R., with office in the South Terminal Station, Boston, Mass., succeeding B. S. Hinchley, transferred to other duties.

A. W. GIBBS, general superintendent of motive power of Pennsylvania Railroad lines east of Pittsburg, has been appointed chief mechanical engineer, succeeding to the duties of T. N. Ely, former chief of motive power, who retired from active service July 1.

R. N. DURBOROW, superintendent of motive power of the Eastern Pennsylvania division of the Pennsylvania Railroad, at Altoona, Pa., has been appointed general superintendent of motive power of lines east of Pittsburg and Erie.

ROBERT K. READING, superintendent of motive power of the Buffalo and Allegheny Valley division of the Pennsylvania Railroad, at Buffalo, N. Y., succeeds R. N. Durborow, and William Eliner, Jr., master mechanic of the Pittsburg division, succeeds Mr. Reading.

B. S. HINCHLEY, formerly engineer of tests, New York, New Haven and Hartford R. R., has been appointed purchasing agent, with office in the North Station, Boston, Mass., succeeding C. N. Chevalier, who retired from active service July 1.

F. S. RODGER general car and locomotive foreman of the Chicago, Milwaukee & St. Paul Ry. at Marion, Iowa, has been appointed assistant district master mechanic of the Superior division, with office at Green Bay, Wis., succeeding E. Z. Hermansader, promoted.

C. H. HEDGCOCK, chief clerk in the mechanical department of the Louisville & Nashville Ry., at Louisville, Ky., has been appointed assistant superintendent of machinery of that company, the organization now including two assistant superintendents in the mechanical department.

W. H. BRADLEY, formerly master mechanic of the Iowa division of the Chicago & North Western Ry. at Clinton, Iowa, has been appointed master mechanic of the East Iowa division, with office at Clinton, Iowa. This change is incidental to the dividing of the Iowa division into the East Iowa and West Iowa divisions.

CHARLES F. GILES, assistant superintendent of machinery of the Louisville & Nashville Ry., at Louisville, Ky., has been appointed superintendent of machinery, succeeding T. H. Curtis, resigned. Mr. Giles was born at Rowlesburg, W. Va., November 2, 1856, and entered railway service as an apprentice in the shops of the Baltimore & Ohio R. R. at Wheeling in 1873, and in the shops of that road, the Texas & Pacific Ry., the Pennsylvania R. R., and the Louisville & Nashville Ry. he remained until 1882, in which year he was made foreman on the L. & N. In 1887 he was promoted to the position of master mechanic, at Birmingham; the next year to a similar position at Pensacola, and on October 1, 1902, became master mechanic at the main shops of the company at Louisville. He was appointed assistant superintendent of machinery on February 1, 1904.

CATALOGS

BEARING METAL.—The quarterly number of "The Graphose Age," published by the Chicago Bearing Metal Co., of Chicago, Ill., has appeared with its usual attractiveness, and in addition to its medley of good humor is not lacking in some plain truths concerning the good service which may be expected from the Graphose bronze locomotive bearings. This issue is well worth reading.

MACHINE TOOLS.—Descriptive of their exhibit at the Atlantic City Conventions, Manning, Maxwell & Moore, Inc., issued a very attractive catalog in which was illustrated the line of machines which were in operation, and of which practical demonstrations were given. These included a working exhibit of "National" bolt and nut machinery, showing the latest direct motor driven designs, including a National wedge grip bolt header; a new National semi-automatic nut tapper; a National quadruple bolt cutter and a National die sharpener.

LEATHER BELTING.—The June issue of "The Phoenix," published by the New York Leather Belting Co., at 51 Beekman St., New York, in addition to its regular monthly instructive and well presented matter on the general subject of belting, mentions the addition of two more companies to the selling family. These are the Carlton Hardware Company, of Calumet, Mich., and the Equipment Company, of Kansas City, Mo., who recently absorbed certain branches of the business of the Mercantile Lumber & Supply Co. of that city.

VALVE GEARS.—The Pilliod Brothers Company, of Toledo, O., has issued a new catalog descriptive of its "crosshead connection" valve gear, which is fast winning recognition as a thoroughly practical and simplified method of valve control. The catalog, in addition to a thorough analysis of the motion, contains half tones showing its application to a locomotive of the Duluth, Toledo and Ironton Ry. and to one of the Delaware and Hudson Company. The subject in general is timely and the catalog should be carefully perused by those interested.

MACHINE TOOLS.—The Gisholt Machine Co., of Madison, Wis., has issued an interesting historical leaflet in which an explanation is given regarding the name and in brief some of the early history of the company, which was founded nearly twenty-five years ago by John A. Johnson, of Madison, Wis. The leaflet contains a half tone illustration of C. O. Johnson, president and general manager, and H. S. Johnson, vice-president and works manager, posed in their working clothes. A cut of the first plant is also shown, which served until more room was necessary, when removal was made to the present shop. The latter is now in turn very inadequate in size, and is in process of expansion to properly care for the large and constantly growing business.

BALL BEARINGS.—The employment of ball bearings in wood working machinery, and in our and feed milling machinery, is described and illustrated by the Hess-Bright Mfg. Co., of Philadelphia, Pa., in recently published catalogs which treat on the two applications most comprehensively. Particularly in connection with woodworking machinery the descriptive matter is of much interest. The ordinary causes of heating are pointed out, attention called to the liability to fire, and the methods explained through which they may be prevented. It is pointed out that these ball bearings as applied to flour and feed milling machinery reduce by one-third to one-half the power required to drive the mill, and a corresponding reduction may be made in the width or extension of the belt, and a material saving in belting renewals effected.

NOTES

STANDARD RAILWAY EQUIPMENT CO.—This company of St. Louis, Mo., has moved its general office to the Frick Building, Pittsburgh, Pa.

AMERICAN LOCOMOTIVE CO.—W. T. Rupert has been sent by this company to Japan to superintend the setting up of several locomotives recently shipped to that country.

BETTENDORF AXLE CO.—W. P. Bettendorf, president of this company, of Bettendorf, Iowa, died at his home in the latter city, Friday, June 3. Mr. Bettendorf was born in Mendota, Ill., July 1, 1857. He was the eldest of four children.

WESTINGHOUSE ELECTRIC & MFG. CO.—The New York, New Haven and Hartford R. R. Co. has placed an order with the above company for fourteen articulated-truck switching locomotives. Each locomotive is to be equipped with a quadruple equipment of No. 410 motors and type H. B. Unit Switch control.

RALSTON STEEL CAR CO.—This company of Columbus, O., has recently opened an office in the Henry W. Oliver Building, room 2438, Pittsburgh, Pa. This office is in charge of C. S. Rea, who represents the Ralston Steel Car Co. in the Pittsburgh district. Prior to the opening of this office Mr. Rea was temporarily at room 604 of the same building.

BROWN HOISTING MACHINERY CO.—Harvey H. Brown has been elected president of this company of Cleveland, O., succeeding his brother, the late Alexander E. Brown, founder of the company, who died April 26. Other officers were elected as follows: Alexander C. Brown, director and vice-president; George C. Wing, secretary; Charles T. Pratt, treasurer, and Richard B. Sheridan, general manager.

HOMESTEAD VALVE MFG. CO.—Announcement has been made by this company of Pittsburgh, Pa., that Frederick K. Blanchard, 422 River St., Troy, N. Y., will represent the firm in the cities of Albany and Troy, N. Y., and vicinity. Mr. Blanchard will have quite a stock of Homestead Valves on hand at all times and will be prepared to supply the engineer and power plants of those cities with Homestead Valves on short notice.

EXHIBITORS AT ATLANTIC CITY

Acme Supply Co., Chicago, Ill.
Adams & Westlake Co., Chicago, Ill.
Ajax Mfg. Co., The, Cleveland, O.
American Arch Co., New York, N. Y.
American Balance Valve Co., Jersey Shore, Pa.
American Brake Co., St. Louis, Mo.
American Brake Shoe & Fdy. Co., Mahwah, N. J.
American Car & Fdy. Co., New York, St. Louis and Chicago.
American Locomotive Co., New York, N. Y.
American Mason Safety Tread Co., Boston, Mass.
American Nut & Bolt Fastener Co., Pittsburgh, Pa.
American Radiator Co., Chicago, Ill.
American Steel Foundries Co., Chicago, Ill.
American Tool Works Co., Cincinnati, O.
American Vanadium Co., Pittsburgh, Pa.
Anchor Packing Co., Philadelphia, Pa.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Armstrong Bros., Tool Co., Chicago, Ill.
Atlas Car & Mfg. Co., Cleveland, O.
Automatic Ventilator Co., New York, N. Y.

Baldwin Locomotive Works, Philadelphia, Pa.
Berry Bros., Ltd., Detroit, Mich.
Besly & Company, Charles H., Chicago, Ill.
Bettendorf Axle Co., Bettendorf, Ia.
Bird & Co., J. A. & W., Boston, Mass.
Bowser & Co., Inc., S. F., Ft. Wayne, Ind.
Buckeye Steel Castings Co., Columbus, O.
Buffalo Brake Beam Co., New York, N. Y.
Bullard Machine Tool Co., Bridgeport, Conn.
Burroughs Adding Machine Co., Detroit, Mich.
Buyers' Index Co., Chicago, Ill.

Camel Co., Chicago, Ill.
Carborundum Co., The, Niagara Falls, N. Y.
Carey Company, Philip, Cincinnati, O.
Carnegie Steel Co., Pittsburgh, Pa.
Carter Iron Co., Pittsburgh, Pa.
Chase & Co., L. C., Boston, Mass.
Chicago Car Heating Co., Chicago, Ill.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chicago Railway Equipment Co., Chicago, Ill.
Chicago Steel Car Co., Chicago, Ill.
Chicago Varnish Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., The, Cleveland, O.
Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Coe Brass Mfg. Co., Ansonia, Conn.
Coe Mfg. Co., W. H., Providence, R. I.
Colonial Steel Co., Pittsburgh, Pa.
Commercial Acetylene Co., The, New York, N. Y.
Commonwealth Steel Co., St. Louis, Mo.
Consolidated Car Heating Co., Albany, N. Y.
Cooper-Hewitt Electric Co., Hoboken, N. J.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Crucible Steel Co. of America, Pittsburgh, Pa.
Curtain Supply Co., Chicago, Ill.

Dahlstrom Metallic Door Co., Jamestown, N. Y.
Damascus Brake Beam Co., The, Cleveland, O.
Davis-Bounonville Co., New York, N. Y.
Davis Solid Truss Brake Beam Co., Wilmington, Del.
Dearborn Drug & Chemical Works, Chicago, Ill.
Detroit Hoist & Machine Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Dickinson, Inc., Paul, Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Dressel Railway Lamp Works, The, New York, N. Y.
Duff Mfg. Co., The, Pittsburgh, Pa.
Dublin Automatic Safety Car Coupler Co., of Canada, Ltd., Sarnia, Ont.

Eagle Glass & Mfg. Co.,
Edison Storage Battery Co., Orange, N. J.
Edwards Company, The O. M., Syracuse, N. Y.
Electric Controller & Mfg. Co., Cleveland, O.
Electric Storage Battery Co., Philadelphia, Pa.
Emery Pneumatic Lubricator Co., St. Louis, Mo.
Enterprise Railway Equipment Co., Chicago, Ill.

Faessler Mfg. Co., J., Moberly, Mo.
Fairbanks, Morse & Co., Chicago, Ill.
Flannery Bolt Co., Pittsburgh, Pa.
Flower Waste & Packing Co., New York, N. Y.
Ford & Johnson Co., The, Michigan City, Ind.
Forsythe Brothers Co., Chicago, Ill.
Fort Pitt Iron Works, Pittsburgh, Pa.
Foster Co., The Walter H., New York, N. Y.
Franklin Mfg. Co., The, Franklin, Pa.
Franklin Railway Supply Co., New York, N. Y.
Frost Railway Supply Co., The, Detroit, Mich.

Galena Signal Oil Co., Franklin, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Electric Co., Schenectady, N. Y.
General Railway Supply Co., Chicago, Ill.
Gold Car Heating & Lighting Co., New York, N. Y.
Goldschmidt Thermit Co., New York, N. Y.
Gould Coupler Co., New York, N. Y.
Greene, Tweed & Co., New York, N. Y.
Greenlaw Mfg. Co., Boston, Mass.
Grip Nut Co., Chicago, Ill.

Hale & Kilburn Mfg. Co., Philadelphia, Pa.
Hammett, H. G. Troy, N. Y.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Hewitt, H. H., New York, N. Y.
Hobart-Allfree Co., Chicago, Ill.
Home Rubber Co., Trenton, N. J.
Hunt Co., C. W., New York, N. Y.
Hunt-Spiller Mfg. Co., South Boston, Mass.
Hutchins Car Roofing Co., Detroit, Mich.
Illinois Steel Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Industrial Supply & Equipment Co., Chicago, Ill.
International Correspondence Schools, Scranton, Pa.
Jacobs-Schupert U. S. Fire Box Co., Coatesville, Pa.
Jenkins Bros., New York, N. Y.
Jessop & Sons, Inc., New York, N. Y.
Johns-Manville Co., H. W., New York, N. Y.
Joliet Railway Supply Co., Joliet, Ill.
Jones & Laughlin Steel Co., Pittsburgh, Pa.
Joyce, Cridland Co., The, Dayton, O.

Kennicott Co., The, Chicago, Ill.
Kerite Insulated Wire & Cable Co., New York, N. Y.
Keystone Drop Forge Works, Chester, Pa.
King Fifth Wheel Co., Philadelphia, Pa.
Kirby Equipment Co., Chicago, Ill.
Knight Pneumatic Sander Co., Huntington, Ind.

Landis Machine Co., Waynesboro, Pa.
Landis Tool Co., Waynesboro, Pa.
Linde Air Products Co., Buffalo, N. Y.
Locomotive Improvement Co., The, Clinton, Ia.
Locomotive Superheater Co., New York, N. Y.
Lucas Machine Tool Co., Cleveland, O.
Lunkenheimer Co., The, Cincinnati, O.
Lupton's Sons Co., David, Philadelphia, Pa.

McClellon, J. M., Boston, Mass.
McConway & Torley Co., The, Pittsburgh, Pa.
McCord & Co., Chicago, Ill.
Main Belting Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York, N. Y.
Massachusetts Mohair Plush Co., Boston, Mass.
Matthews-Davis Tool Co., St. Louis, Mo.
Michigan Lubricator Co., Detroit, Mich.
Midvale Steel Co., Philadelphia, Pa.
Mid-Western Car Supply Co., Chicago, Ill.
Milburn Co., Alexander, Baltimore, Md.
Moore & Co., Benjamin, Brooklyn, N. Y.
Moran Flexible Steam Joint Co., Louisville, Ky.
Mudge & Co., Burton W., Chicago, Ill.

Nathan Mfg. Co., New York, N. Y.
National Lock Washer Co., Newark, N. J.
National Malleable Casting Co., Cleveland, O.
National Tube Co., Pittsburgh, Pa.
Nelson Valve Co., Philadelphia, Pa.
Newhall Engineering Co., George M., Philadelphia, Pa.
New York Air Brake Co., New York, N. Y.
Nickel-Chrome Chilled Car Wheel Co., Pittsburgh, Pa.
Niles-Bement-Pond Co., New York, N. Y.
Norton, Inc., A. O., Boston, Mass.

Pantasote Co., New York, N. Y.
Parker Car Heating Co., Ltd., London, Ontario.
Parkesburg Iron Co., Parkesburg, Pa.
Parsons Engineering Co., Wilmington, Del.
Pennsylvania Flexible Metallic Tubing Co., Cleveland, O.
Pilliod Brothers, Toledo, O.
Pilliod Company, New York, N. Y.
Pittsburgh Equipment Co., Pittsburgh, Pa.
Pneumatic Jack Co., Inc., Louisville, Ky.
Post & Co., Inc., E. L., New York, N. Y.
Pressed Steel Car Co., Pittsburgh, Pa.
Pyle-National Electric Headlight Co., Chicago, Ill.
Pyrene Mfg. Co., New York, N. Y.

Railway Materials Co., Chicago, Ill.
Ralston Steel Car Co., Columbus, O.
Remington Typewriter Co., New York, N. Y.
Restein Co., Clement, Philadelphia, Pa.
Rock Island Mfg. Co., Rock Island, Ill.
Rockwell Furnace Co., New York, N. Y.
Royersford Foundry & Machine Co., Inc., Royersford, Pa.
Rubberset Company, Newark, N. J.
Safety Car Heating & Ltg. Co., New York, N. Y.
Scarritt-Comstock Furniture Co., St. Louis, Mo.
Scullin-Gallagher Iron & Steel Co., St. Louis, Mo.
Sellers & Co., Inc., William, Philadelphia, Pa.
Sherwin-Williams Company, Cleveland, O.
Simplex Railway Apppliance Co., New York, N. Y.
Sipe & Company, James B., Pittsburgh, Pa.
Smith Premier Typewriter Co., Syracuse, N. Y.
Sprague Electric Works of General Electric Co., New York.
Standard Coupler Co., New York, N. Y.
Standard Steel Car Co., New York, N. Y.
Standard Steel Works Co., Philadelphia, Pa.
Storrs Mica Co., Owego, N. Y.
Street, Clement F., Schenectady, N. Y.
Strong, Carlisle, Hammond Co., Cleveland, O.
Summers Steel Car Co., Pittsburgh, Pa.
Symington Co., The T. H., Baltimore, Md.
Templeton, Kenly & Co., Ltd., Chicago, Ill.
Topping Bros., New York, N. Y.
Trill Indicator Co., Corry, Pa.
Tyler Co., The W. S., Cleveland, O.

Underwood & Co., H. B., Philadelphia, Pa.
Union Draft Gear Co., Chicago, Ill.
Union Fibre Co., Winona, Minn.
Union Mfg. Co., New Britain, Conn.
Union Spring & Mfg. Co., Pittsburgh, Pa.
United Engineering & Foundry Co., Pittsburgh, Pa.
United States Light & Heating Co., New York, N. Y.
U. S. Metal & Mfg. Co., New York, N. Y.
U. S. Metallic Packing Co. Philadelphia, Pa.
United States Radiator Corporation, Detroit, Mich.
Universal Safety Tread Co., Boston, Mass.

Van Dorn & Dutton Co., Cleveland, O.
Van Dyck Churchill Co., New York, N. Y.

Ward Equipment Co. New York N. Y.
Warner & Swasey Co., Cleveland, O.
Welsbach Company, Gloucester, N. J.
West Disinfecting Co., New York, N. Y.
Western Railway Equipment Co. St. Louis Mo.
Western Steel Car & Fdy. Co., Hegewisch, Ill.
Western Wheeled Scraper Co., Aurora, Ill.
Westinghouse Air Brake Co., Pittsburgh, Pa.
Westinghouse, Church, Kerr & Co., New York, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Westinghouse Lamp Co., Bloomfield, N. J.
Westinghouse Machine Co., East Pittsburgh, Pa.
Wheel Truing Brake Shoe Co., Detroit, Mich.
Williams All Service Car Door Co., Clinton, Ill.
Wilson Remover Co., New York, N. Y.
Wood, Guilford S., Chicago, Ill.
Wood Locomotive Fire Box & Tube Plate Co., The William H., Media, Pa.

Yale & Towne Mfg. Co., New York, N. Y.

Zug Iron & Steel Co., Pittsburgh, Pa.

Locomotive Terminal at New Durham, N. J.

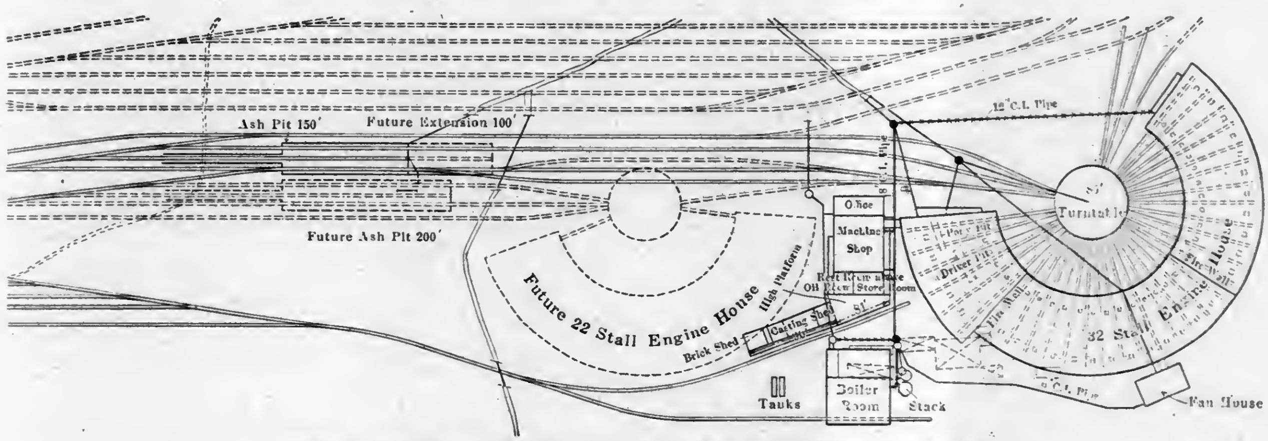
THE NEW ROUNDHOUSE AND BUILDINGS RECENTLY ERECTED AT THIS POINT BY THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD CONSTITUTE A FINE EXAMPLE OF A MODERN LOCOMOTIVE TERMINAL, DESIGNED WITH THE END IN VIEW TO PROVIDE FOR THE REQUIREMENTS OF THE FUTURE

In keeping with its policy to rehabilitate on distinctively modern lines existing locomotive terminals included in the system, or, where such rehabilitation is impossible or considered inadvisable, to provide an entirely new plant, the New York Central and Hudson River Railroad has recently abandoned the old West Shore roundhouse with its accompanying layout at New Durham, N. J., and erected in that vicinity a new terminal largely in accordance with its established standards as exemplified at other points on its lines. The latter is adequate and well-appointed in every detail, and in addition it has been very wisely planned to meet the inevitable expansion of business on this part of the system in the future, without the acquisition of additional property, and without change in the existing buildings which at present comprise the new plant.

The old terminal at New Durham proper constituted the shops of the West Shore Railroad at the time of its acquisition by the New York Central, and for several years had been considered unsuitable to meet the demands imposed by the metamorphosis in locomotive design which has been the feature of the last decade or so. The shop buildings and the roundhouse are largely of frame construction, and the latter would not accommodate modern power to the extent of allowing it to be worked on effectively. A move to more suitable quarters would no doubt have been effected long since had it been possible to secure the proper site, where the building operations might be economically conducted, and the necessary property acquired without a prohibitive initial expenditure.

The location finally determined upon is about one mile north of the original shops, or midway between New Durham and Babbitt, at a point where the wide expanse of the Hackensack meadows on the west begins a rather abrupt upward slope towards the Palisades of the Hudson River on the east. Although the main line of the railroad lies somewhat to the west of the new terminal, and on the meadows proper, the marshy condition of the soil where building was commenced, and the irregular profile of the location, necessitated that about one-half of the plant be erected on a fill, and a considerable amount of piling became imperative for foundation supports. Nevertheless, in the face of these engineering difficulties the work has been completed in a most satisfactory manner and thoroughly bears the impress of permanency.

The buildings consist of a 32-stall roundhouse, with an 85-foot turntable operated by an electric tractor; a combined machine shop, store room, oil house, engineers' rest room and office building, and a power house containing the boiler wash-out system and air compressors. The entire arrangement, as will be noted in the accompanying general plan, is remarkably compact. The usual severity of the winters in this section has been apparently borne prominently in mind in the grouping of the various structures, as it is possible for the foremen and workmen to move largely under cover throughout the principal buildings. An additional advantage also obtained through this disposition is a material shortening of all pipe lines from the power house, to a far less extent in fact than may be observed in connection with

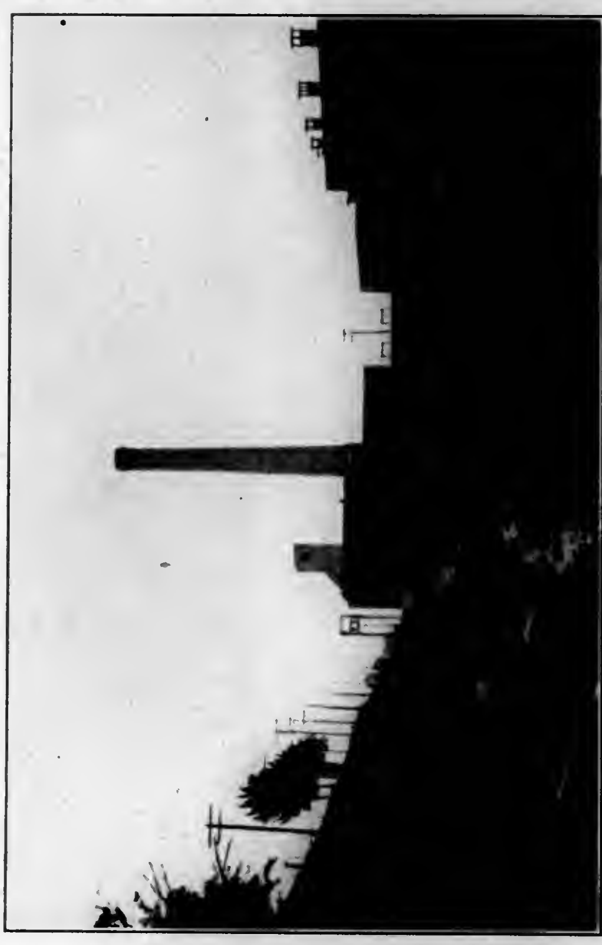


GENERAL PLAN OF NEW YORK CENTRAL TERMINAL AT NEW DURHAM, N. J.

much smaller plants recently constructed, but where the various components have for some reason been isolated.

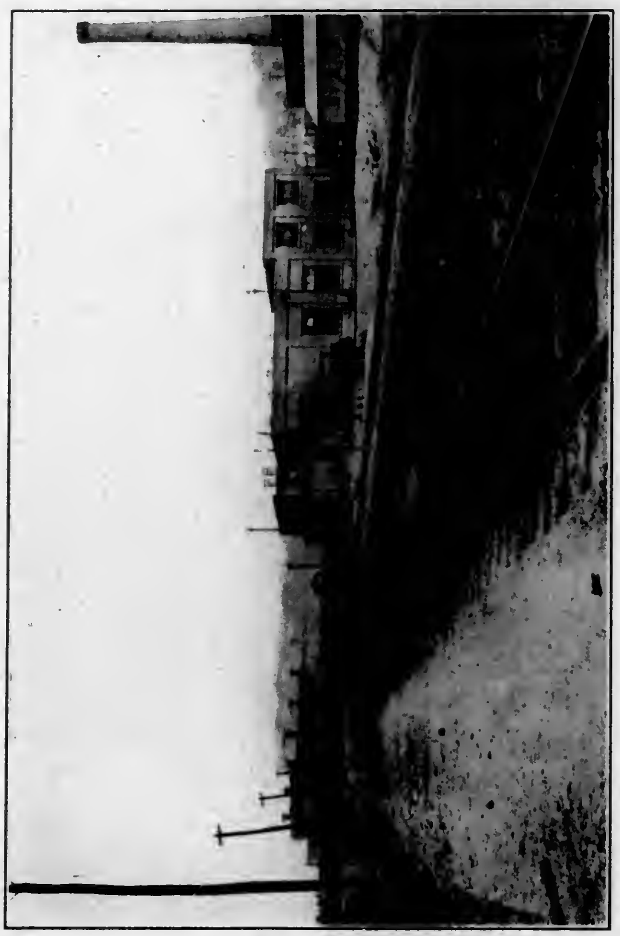
In further consideration of the general plan the fact of course becomes apparent that the ash pit is considerably removed from the roundhouse, but this location was considered most advisable in view of the possible erection in the future of an additional 25-stall roundhouse between the present one and the ash pits, thus allowing the latter to take care of any possible expansion without relocation. The absence of a coaling station in the immediate vicinity of the new plant is noticeable, but this arises from the fact that the old trestle is in too good condition to abandon, and the locomotives continue to coal at it as they pass on their way to and from the freight yard and passenger station in Weehawken. A large modern one, however, is contemplated and space reserved for it in connection with the new terminal, but it may not be constructed for a few years.

Differing from the plan employed at other points on the New York Central lines, inspection pits have not been provided in connection with this terminal, although they may receive consideration when the plant has become fully developed. At present the incoming locomotives are delivered to the shop at the ash pits, and the necessary inspections are made on their arrival at the roundhouse. The track arrangement is such, as will be seen in the plan, that the outgoing engines return in the same direction from which they entered, there being an independent track for their movement on the west of the ash pits. The total power handled is about 100 engines in 24 hours of all classes, passenger, freight and switching. Although the old erecting shop has been retained at the original plant, all of the heavier running repairs are cared for in the new roundhouse, and it is self-supporting so far as maintaining the locomotives is concerned until they are ready to receive classified work.



THE POWER HOUSE, CONTAINING WASHOUT SYSTEM AND AIR COMPRESSORS.

ROUNDHOUSE INTERIOR, SHOWING AMPLE CLEARANCE.



NEW DURHAM TERMINAL VIEWED FROM THE SOUTH.

ELECTRICALLY OPERATED TURNTABLE IN CONCRETE PIT.

The Roundhouse Structure.

This building in constructive features and general arrangement of details follows closely that at Corning, N. Y., and Springfield, Mass., on the same system, each of which has been described and illustrated in previous issues of this journal*, and which may be regarded as standard on the New York Central lines. The foundations are of concrete and the outside walls of brick, in two sections. The upper section, which encloses the roof trusses, is well provided with swinging windows, easily operated from the main floor, and which provide a very perfect system of ventilation. The question of heating and ventilation have, in fact, been most carefully considered in connection with this roundhouse, and the results have exceeded expectations. A very noticeable feature of this building is its absolute freedom from smoke and gas fumes, even when three or four engines are being fired up in one section simultaneously. Twenty-two of the smokejacks were designed by the Franklin Mfg. Co., 50 Church street, New York, and ten smokejacks by the Johns-Manville Co. of New York, and are most effective for the purpose intended. In these designs the jacks are of asbestos lumber, and having a length of 8 ft., permit considerable movement of the locomotive, a very important consideration in a terminal such as this where valve setting is frequently performed with the engine under steam. The jacks over the drop pits are made 31 ft. long, providing for the greatest possible range of position of the locomotive underneath.

Scarcely secondary in importance to this desirable feature is the heating system, which during the severest weather of the past winter thoroughly demonstrated its efficiency. In this installation the hot air blast system was erected complete by the Bayley Mfg. Co., of Milwaukee, Wis., in a fan room adjacent to and abutting from the west wall of the roundhouse.

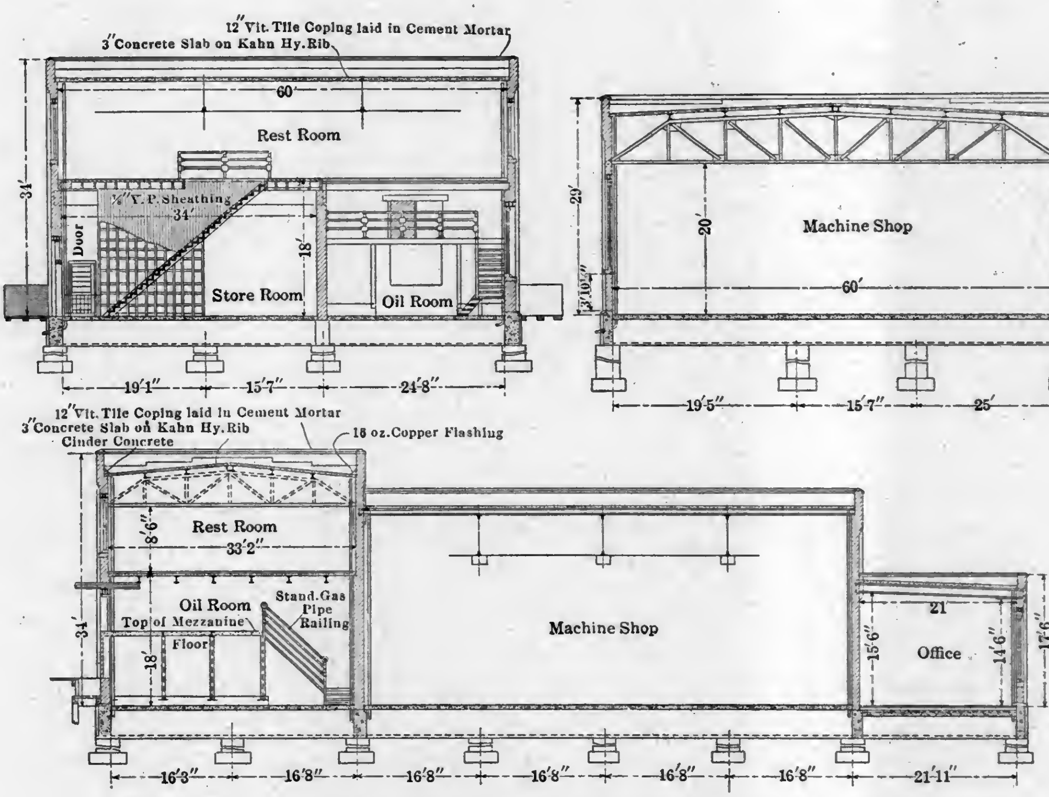
Two distinct fans and engines have been provided, both of which when operated at moderate load will maintain a temperature on the coldest days from 50 to 75 degrees F., provided that reasonable care is exercised in promptly closing the doors after incoming and outgoing engines. In moderate weather one heating unit will keep the house comfortable.

Ample provision has been made for the heavier locomotive repairs in connection with wheel dropping, and both engine and truck wheel removals, by providing two driver and two truck drop pits in the section of the roudhouse nearest the machine shop. This portion is also served by an industrial track equipped with conveniently arranged turntables. The design and construction of these pits, which are standard on this railroad, was described in the American Engineer, Dec., 1910, page 467. The tracks in which they are located are some 23 feet longer than those in other parts of the house, thus permitting the rear driving wheels to be handled on the engine drop pits without cutting the tender off and backing the locomotive in, which is a very customary procedure in many other less modern shops.

Machine Shop and Office Building.

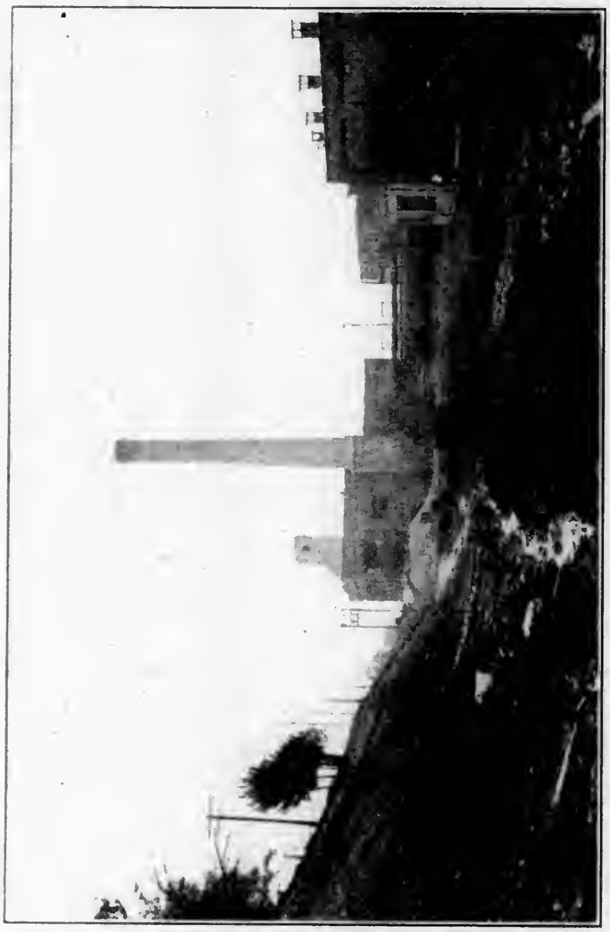
The convenient proximity of this structure to the roundhouse has been commented upon. It is also of brick on concrete foundations, with an area of 60 feet by 120 feet, and contains on the first floor, from west to east, the office space, 21 feet by 60 feet, in which is included that of the master mechanic, chief clerk, roundhouse foreman, and the engine dispatcher, this portion of the building being connected to the roundhouse by a covered passageway; the machine shop, 66 feet by 60 feet; the storeroom, 33 feet by 34 feet, and the oil room, 24 feet by 33 feet. Over the latter two departments is a very commodious engineers' rest room, with a floor area of 33 feet by 60 feet. As will be noted from the sectional drawings herewith, this building is of the most substantial construction. It has been admirably planned for the convenience of the engine crews, who, for instance, after leaving their engines on the ash pit and on arriving at the shop building, pass first the engine dispatcher's office, where they register; next the oil room, where the cans are delivered, and from thence a stairway leads to the rest room should they care to make use of it.

The north side of this combination building has a 6-foot board walk, and immediately in the rear a high platform has been erected which gives access to the casting shed. These details are very clearly indicated in the general plan, and in this consideration it is interesting to note that in the event of the future 25-stall roundhouse being constructed it can be served with the same facility as the house now in operation.



SECTIONAL VIEWS OF COMBINED STORE ROOM, OIL HOUSE, MACHINE SHOP AND OFFICE BUILDING.

* See Amer. Engr., Dec., 1910, and Jan., 1910, respectively.



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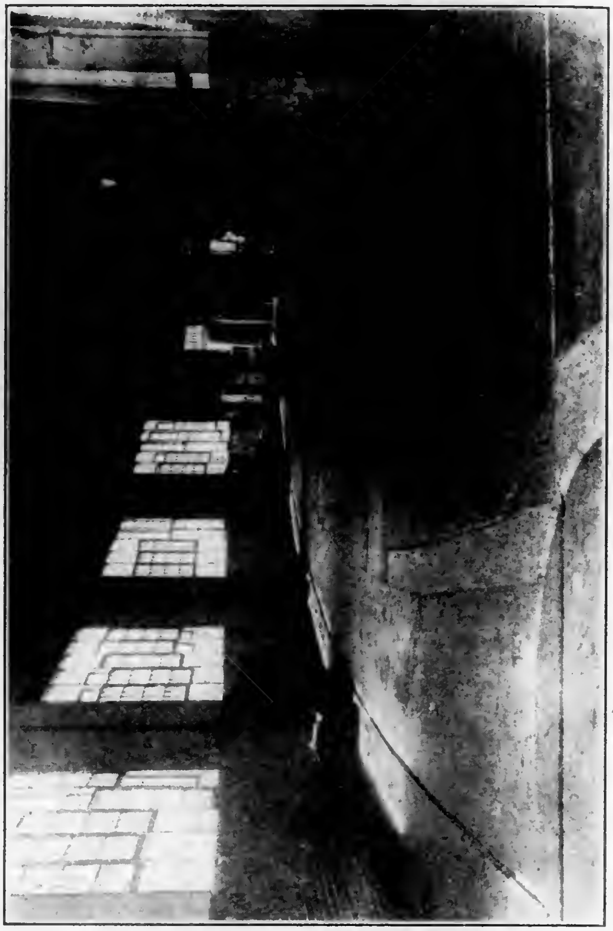

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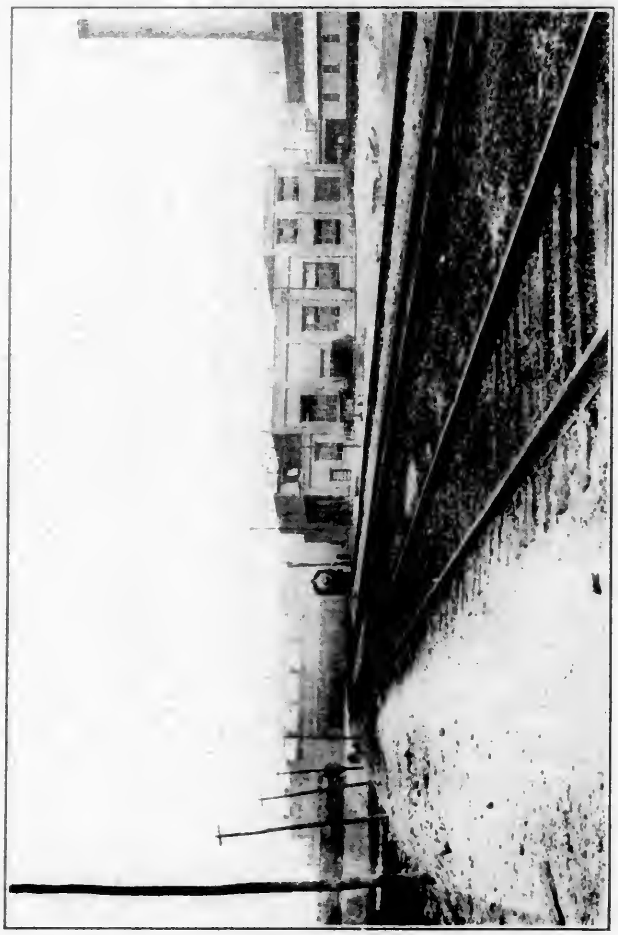

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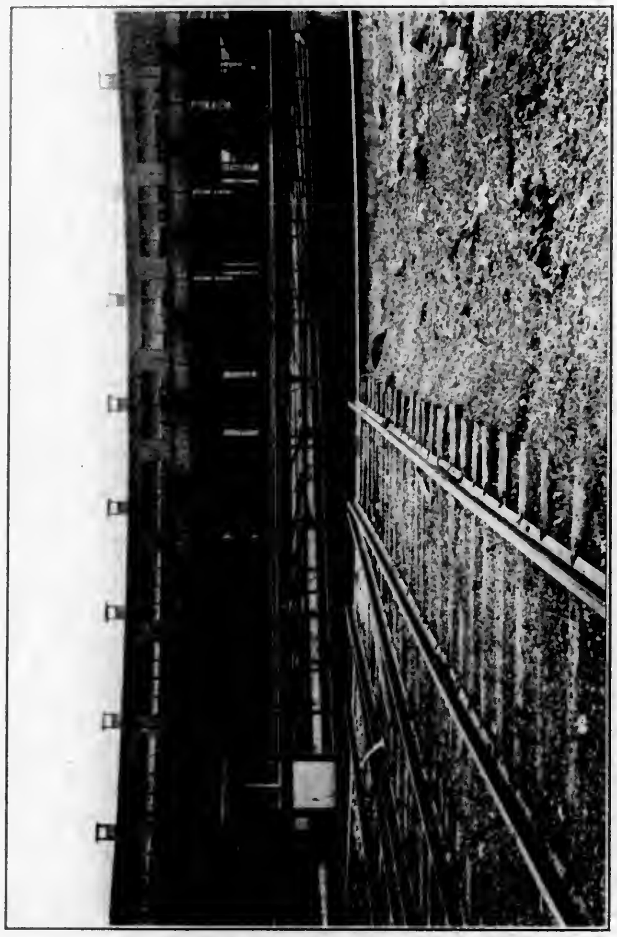

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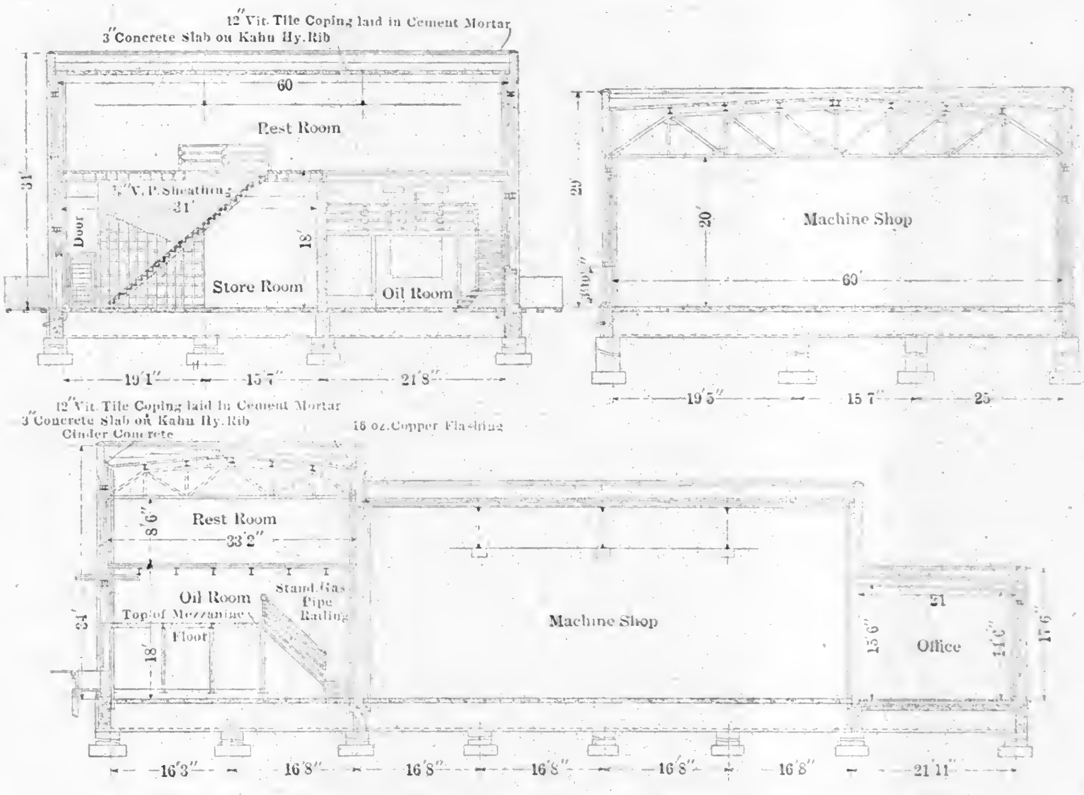

Sectional Views of Combined Store Room, Oil House, Machine Shop and Office Building.

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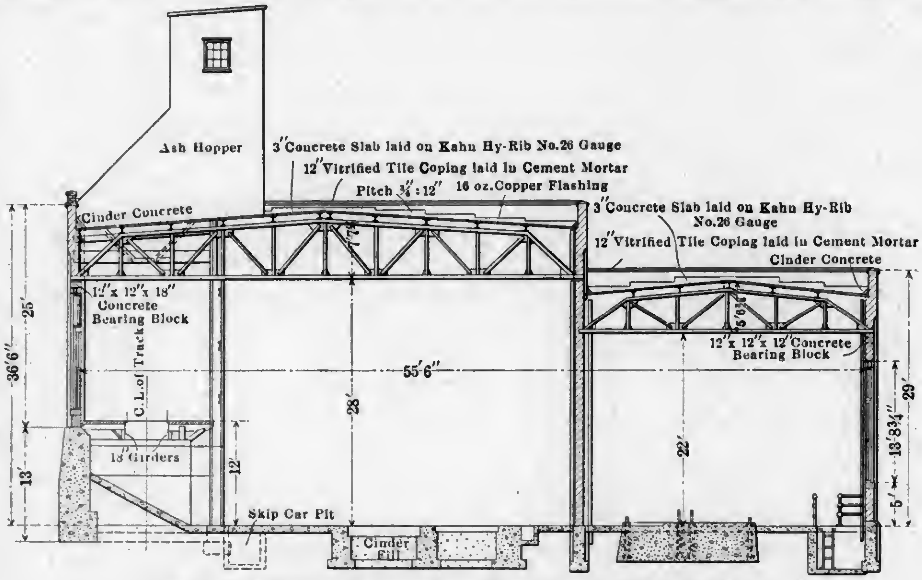
The Power House.

This building embodies a departure from existing similar structures on the New York Central lines in many details, and may be said to present the most up-to-date construction and equipment in that line of any heretofore erected by this company. The area occupied is 77 feet by 87 feet, from west to east, as an engine room, 31 feet 6 inches in depth, and a boiler room 55 feet 6 inches deep, the latter having the full width of 77 feet. Fifteen feet of the engine room has been partitioned off to provide for an exceptionally well equipped toilet, and wash room. The sectional drawing shows the principal dimensions of the two divisions of the building, which, it will be noted, are separated by a 12-inch wall. The equipment in the smaller section consists of a duplex Ingersoll-Rand air compressor, type H, with a capacity of 1,500 cubic feet of free air per minute, and the National Boiler Washing Company's system for hot water boiler washing and filling*, a duplicate of that which has been installed at Corning, N. Y., and at the other terminals of this company.

The demand imposed upon this system at New Durham is exceptionally severe, some fifteen boilers being washed daily, in addition to the usual number which are emptied or have the water lowered. The filling pump has a capacity of 500 gallons per minute, and the washout pump will take care of three boilers simultaneously, maintaining a pressure of 90 pounds. The filling water tank has a storage capacity of about 12,000 gallons, and the washout tank of about 8,500 gallons.



SECTION OF POWER HOUSE THROUGH BOILER AND ENGINE ROOM.

The arrangement of these appliances in the power house is particularly pleasing, and they have been so effectively disposed that notwithstanding their bulk and the large floor space occupied, the room appears to be quite open and unobstructed. This has been attained by placing the air compressor on the extreme right of the large double doors on the east side, and the boiler washing system on the extreme left, thereby leaving an open space of at least 20 feet between the two appliances, this space leading into the boiler room, which takes up the western end of the building.

INTERIOR OF BOILER ROOM—ASH HOIST ON LEFT

This section contains 3 water tube boilers built by Erie City Iron Works, of 300 horsepower each, an ample sufficiency to provide for all requirements of the plant. Ordinarily two boil-

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ers will be sufficient to carry the load. The equipment of the boiler room includes a very effective automatic reversing pneumatic ash hoist, built and installed by R. H. Beaumont & Co., of Philadelphia, Pa. The general arrangement of this device consists of a self-dumping steel skip, of 20 cubic feet capacity, operated by a 14 inch by 14 foot air cylinder. The steel cable is reaved four times on the sheaves of the air cylinder, which provides for a 56-ft. lift of the skip.

As shown in the sectional drawing of the power house, the line of rails for the incoming coal cars containing the boiler room fuel supply is located 12 feet above the floor line, thus allowing these cars to be dumped into bins of large capacity, and this track also serves for the ash car when ashes are to be loaded. By reference to the above mentioned illustration, it will be seen that the operation of the skip is extremely simple The fireman who dumps the barrow load of ashes into the skip merely pulls the cord attached to the air valve. The bucket then raises, dumps into an elevated ash pocket, and returns automatically to the filling pit. The advantage of the design is that air is always available around a railroad yard, and the use of an air cylinder makes certain the stopping of the skip at the upper and lower limits, more positively than any type of winding gear.

The remaining details of the New Durham plant are New York Central standards, which have been frequently alluded to in this journal. The terminal in general is a remarkably fine example of the development which all similar places are gradually undergoing, and is in striking contrast to the one just vacated, which for so many years cared for the power of the West Shore Railroad.

A TRIO OF ODDLY CONTRASTED LOCOMOTIVES

The largest two-stage compressed air locomotive in the world occupies the middle position in the odd assortment of machines represented in the accompanying illustration, which are a recent output of the H. K. Porter Co., of Pittsburgh, Pa. It is of the four-wheel type with a main reservoir consisting of three tanks 40 in. in diameter. Two of these are 15 feet long and the third is 17 feet, all being connected. This locomotive was built for use at a powder magazine. It will start five loaded freight cars on a level track and will haul two loaded steel coal cars a distance of five miles on one charge of air.

In view of the exceptional size and power of the engine the following principal dimensions may be of interest:

H. P. cylinder	11 x 18 in.
L. P. cylinder	22 x 18 in.
Wheels	36 in. diam.
Rigid wheelbase	5 ft. 9 in.
Weight of engine	55,000 pounds
Capacity main reservoir	375 cu. ft.
Tractive effort	10,000 pounds
Height	12 ft.
Width	9 ft. 6 in.
Length	21 ft. 11 in.
Pressure at throttle	250 pounds
L. P. cylinder pressure	50 pounds
Main reservoir pressure	825 pounds

The small steam locomotive which brings up the rear was built for plantation use in Nicaragua. It is of the four-wheel type with side tanks and a steel canopy cab. The cylinders are 5 x 10 in., driving wheels 20 in. diameter, and the rigid wheel base 3 ft. 6 in. The firebox is 26 x 18½ in., with a grate area of 3.34 sq. ft. The boiler, which is of the straight type, 23 in. diameter, has 37 1½ in. tubes, and its total heating surface is 58.9 sq. ft. Despite its diminutive proportions the little locomotive exerts a tractive effort of 1,700 lbs. It will operate on a 30 in. gauge track.

The switch engine leading the group well illustrates the care in finishing which has become so well identified with the output of the H. K. Porter Co. Its remarkably neat appearance for a locomotive of this type is very striking. With the exception of the relatively large boiler there is nothing particularly novel in the general design. The cylinders are 20 x 26 in.; driving wheels 50 in. diameter; tractive effort 35,360 lbs., and total weight 150,000 lbs. The avoidance of complication is prominent and all parts are readily accessible to ordinary running repairs.

NIGHT SCHOOL FOR APPRENTICES

At the Somerset shops of the Cincinnati, New Orleans & Texas Pacific Railway a school has been started for apprentices, which meets on Monday and Thursday nights of each week from 7 to 10 P. M. The railroad has fitted out a room with full equipment capable of accommodating 30 men and the State University of Kentucky furnishes the instructors and supervises the instruction. Beginning at seven o'clock at each instruction period from 30 minutes to an hour is spent by the instructor in discussing some feature of mechanical drawing, mathematics as pertaining to engineering, or some phase of engineering as affecting shop practice. The remaining time is allotted to drawing board work, where each student is allowed to progress as rapidly as his ability will permit.

Four instructors from the school of mechanical and electrical engineering have been assigned to this work, each instructor having the class for two weeks in turn. The apprentices are required to take this course and the expense to them is a maximum of $10 for drawing apparatus and material, all other expense being paid by the railroad.

This school has been started on the instance of T. O. Sechrist, master mechanic of the Ferguson shops at this point, who reports that six weeks operation indicates that the results of this plan are going to be most satisfactory and that the apprentices are taking a very keen interest in the advantages offered them.

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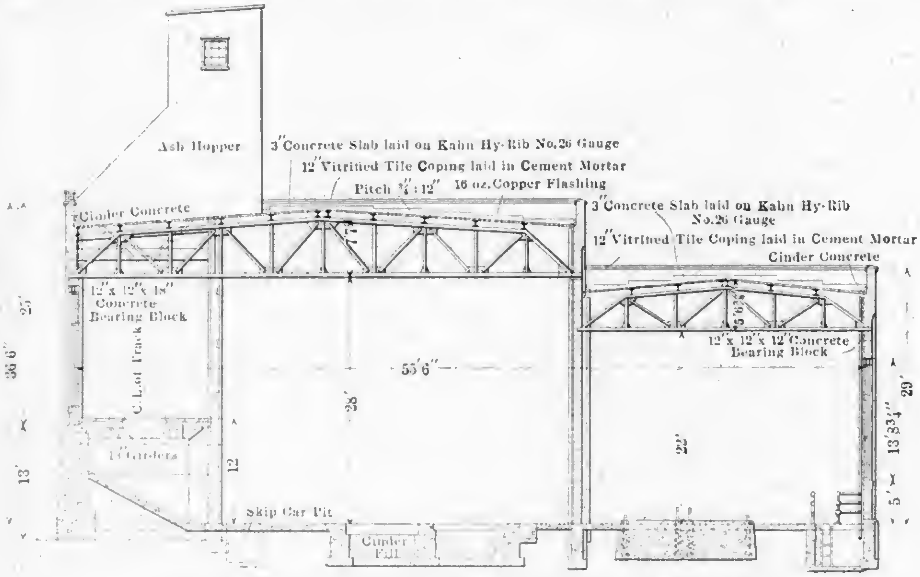

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The remaining details of the New Durham plant are New York Central standards, which have been frequently alluded to in this journal. The terminal in general is a remarkably fine example of the development which all similar places are gradually undergoing, and is in striking contrast to the one just vacated, which for so many years cared for the power of the West Shore Railroad.

A TRIO OF ODDLY CONTRASTED LOCOMOTIVES

The largest two-stage compressed air locomotive in the world occupies the middle position in the odd assortment of machines represented in the accompanying illustration, which are a recent output of the H. K. Porter Co., of Pittsburgh, Pa. It is of the four-wheel type with a main reservoir consisting of three tanks 40 in. in diameter. Two of these are 15 feet long and the third is 17 feet, all being connected. This locomotive was built for use at a powder magazine. It will start five loaded freight cars on a level track and will haul two loaded steel coal cars a distance of five miles on one charge of air.

In view of the exceptional size and power of the engine the following principal dimensions may be of interest:

H. P. cylinder	11 x 18 in
L. P. cylinder	22 x 18 in.
Wheels	36 in. diam.
Rigid wheelbase	5 ft. 9 in.
Weight of engine	55,000 pounds
Capacity main reservoir	375 cu. ft.
Tractive effort	10,000 pounds
Height	12 ft.
Width	9 ft. 6 in.
Length	21 ft. 11 in.
Pressure at throttle	250 pounds
L. P. cylinder pressure	50 pounds
Main reservoir pressure	825 pounds

The small steam locomotive which brings up the rear was built for plantation use in Nicaragua. It is of the four-wheel type with side tanks and a steel canopy cab. The cylinders are 5 x 10 in., driving wheels 20 in. diameter, and the rigid wheel base 3 ft. 6 in. The firebox is 26 x 18½ in., with a grate area of 3.34 sq. ft. The boiler, which is of the straight type, 23 in. diameter, has 37 1½ in. tubes, and its total heating surface is 58.0 sq. ft. Despite its diminutive proportions the little locomotive exerts a tractive effort of 1,700 lbs. It will operate on a 30 in. gauge track.

The switch engine leading the group well illustrates the care in finishing which has become so well identified with the output of the H. K. Porter Co. Its remarkably neat appearance for a locomotive of this type is very striking. With the exception of the relatively large boiler there is nothing particularly novel in the general design. The cylinders are 20 x 20 in.; driving wheels 50 in. diameter; tractive effort 35,360 lbs., and total weight 150,000 lbs. The avoidance of complication is prominent and all parts are readily accessible to ordinary running repairs.

NIGHT SCHOOL FOR APPRENTICES

At the Somerset shops of the Cincinnati, New Orleans & Texas Pacific Railway a school has been started for apprentices, which meets on Monday and Thursday nights of each week from 7 to 10 P. M. The railroad has fitted out a room with full equipment capable of accommodating 30 men and the State University of Kentucky furnishes the instructors and supervises the instruction. Beginning at seven o'clock at each instruction period from 30 minutes to an hour is spent by the instructor in discussing some feature of mechanical drawing, mathematics as pertaining to engineering, or some phase of engineering as affecting shop practice. The remaining time is allotted to drawing board work, where each student is allowed to progress as rapidly as his ability will permit.

Four instructors from the school of mechanical and electrical engineering have been assigned to this work, each instructor having the class for two weeks in turn. The apprentices are required to take this course and the expense to them is a maximum of $10 for drawing apparatus and material, all other expense being paid by the railroad.

This school has been started on the instance of F. O. Sechrist, master mechanic of the Ferguson shops at this point, who reports that six weeks operation indicates that the results of this plan are going to be most satisfactory and that the apprentices are taking a very keen interest in the advantages offered them.

The Speed and Power of Machine Tools

THE ENORMOUS IMPROVEMENTS IN TOOL STEEL AND THE MACHINES FOR USING IT HAVE RESULTED IN NEW PROBLEMS FOR THE MACHINE SHOP WHICH MAY BETTER ADMIT OF SOLUTION AFTER A CAREFUL REVIEW OF THE BEST RECCOMMENDED PRACTICE GOVERNING POWER, CUTS, SPEEDS AND FEEDS.

As a chip producer the lathe is the most economical of machine tools. A well-designed lathe, working under favorable conditions, produces a half-pound of chip per horsepower minute, when cutting mild steel. The pressure on a lathe tool, with this material, is, approximately, 100 tons per square inch area of cut, the latter being the depth multiplied by feed; i. e., a cut ½ in. deep by ⅛ in. feed, has an area of 1/16 sq. in. When cutting cast iron the pressure is about 50 tons per square inch, consequently about one pound of cast iron should be removed per horsepower minute. In a paper read before the English Northeast Coast Institution of Engineers and Shipbuilders, Joseph Chilton dealt very instructively with the speed and power of lathes and machine tools in general. The following discussion is based largely on the data presented in that excellent paper.

Fig. 1 shows the power required for cutting mild steel and cast iron under various conditions as given by Mr. Chilton.

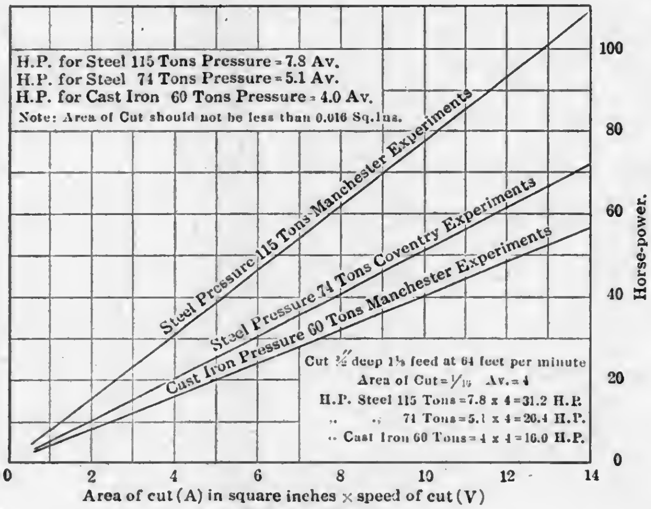


Fig. 1.–Horse Lower of Lathes.

The curve marked "Manchester experiments" is based on a tool pressure of 115 tons per square inch, which allows from 15 to 20 per cent. for friction losses in the machine. The lower curve for mild steel is based on experiments of Alfred Herbert & Co., Coventry, in 1909, when some remarkable results were obtained on a standard capstan lathe, using a tool with a cutting angle of 48 deg., a roller steady, and a copious supply of lubricant.

The power required for a given cut will probably lie between these two curves, as the pressure on the tool varies with the tool angle. Improvements in steel call for alterations in the cutting angle of tools; the better the steel, the more acute can be the cutting angle. The results of the Coventry experiments are interesting, and some of them are shown below. The lathe used admitted a 2¼ in. diameter bar, and the tests, which were carried out under practically commercial conditions, produced the following data:

Test. No.	Reducing. From Inches.	Reducing. To Inches.	Speed. Feet per Min.	Feed. Inches per Min.	Metal Removed. Cubic Inches per Min.	Lbs. per Min.
1	2¼	1	190	11⅜	36.29	10.16
2	2	¾	262	13⅛	36.11	10.11
3	1¾	¾	184	18⅛	35.52	9.94
4	2	1	210	14⅞	35.04	9.81
5	1¾	¾	229	17¾	34.79	9.74
6	2¼	1	236	10⅝	33.89	9.49

The maximum power required was, in test No. 2, 23.7 h.p. Ten years ago a lathe of this size used to be sold with a 2 h.p. motor, whereas one would now be required of 20 h.p. if work similar to the above was to be performed continuously. If the productive capacity of this lathe has increased in the same ratio as the power of the motors supplied, the result is a remarkable index of the progress of the past ten years. As a few examples of everyday practice it may be mentioned that straight shafting is finished from the rolled bar at 160 ft. per minute with 1/32 in. feed; 3 in. diam. shafting is therefore finished at the rate of 6.27 in. of length per minute, 10 ft. in less than 20 minutes. Three tools are used. A 10 in. lathe reduces mild steel forgings ¾ in. diam. with ⅛ in. feed at 60 ft. per minute. A 12 in. lathe reduces mild steel forgings 1 in. in diameter with ⅛ in. feed at 60 ft. per minute. A lathe more than 10 years of age, which has been converted into a direct motor drive, turns 8 in. diam. bolts at 300 ft. per minute, depth of cut ½ in., feed 1/32 in., removing 56 cub. in. of steel per minute. This lathe would probably require about 36 h.p. In an exceptional case an 18 in. lathe took a cut 1½ in. deep by ¼ in. feed at a cutting speed of 28 ft. per minute, the consumption of power being upwards of 80 h.p.

When exceptionally heavy duty is required from a lathe, the single pulley or the direct motor drive will usually be found to be most suitable. The motor, in the direct drive, should be of variable speed, not less than 3 to 1 variation, as this simplifies the change-speed gear and allows of exact speed adjustment. The table below of powers required is based on the belt power provided in some modern lathes.

Height of Centres	Horse-power Required.
6 in.	5
8½ in.	7½
10½ in.	10
12 in.	15
18 in.	30
24 ni.	40
36 in.	60

These powers enable heavy cuts to be carried in steel, the 18 in., 24 in. and 36 in. lathes using two tools.

Nicholson and Smith in their "Lathe Design" give a series of standard cuts and cutting speeds for lathes which are useful as a guide for power required. The standard cut for a 36 in. lathe is .9 deep, by .225 feed, giving an area of 0.203 sq. in., the standard cutting speed 20 ft. per minute. The standard cut for a 6 in. lathe is 0.15 deep by 0.0375 feed, giving an area of 0.0056, with the cutting speed 193 ft. per minute. These cuts and speeds are based upon the durability of the cutting edge of the tool. The tool in the 6 in. lathe is expected to last 16 minutes, and in the 36 in. lathe about 4 hours. Generally speaking, a heavy cut at medium speed is more economical than a light cut at high speed.

The Planing Machine.

The planing machine stands next to the lathe as a cutting remover. In it the high-speed problem has been solved in a scientific manner by both mechanical and electrical methods. The old type planing machine reversing gear is unsuitable for even moderate speeds. A large amount of energy is wasted at the end of each stroke, and a considerable amount of time is lost at each reversal of the table owing to the low accelerative and decelerative power of the gear. Mechanical and electrical systems of regenerative driving have changed this. The energy previously wasted in bringing the table and gearing to rest is now utilized in accelerating the table on its return stroke.

Typical power diagrams of planing machines are shown in Figs. 2-5. The diagram, Fig. 2, was taken from a machine with the old type of driving gear, and the diagram, Fig. 3, from

the same machine with an improved driving gear fitted. It will be seen that more power is needed for the return than for the cutting stroke; but Fig. 3 is an improvement in this respect, the "peak" at the moment of reversal is eliminated, and the power fluctuation minimized. Flywheels, constantly revolving in one direction, are used in this system of driving gear. The diagram, Fig. 4, was taken from a machine of the spring

Fig. 2.—Ordinary Reversing Gear.

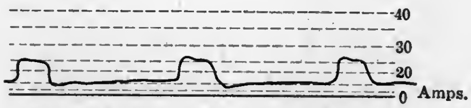


Fig. 3.—Improved Reversing Gear

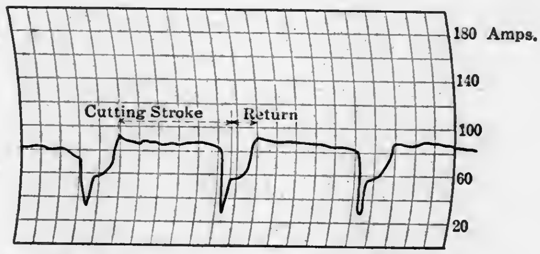


Fig. 4.—Spring Regenerative Reversing Gear.

Machine, 4 ft. by 4 ft. Planing steel ingot 8 ft. long. Cutting speed, 40 ft. per minute. Return, 180 ft. per minute.

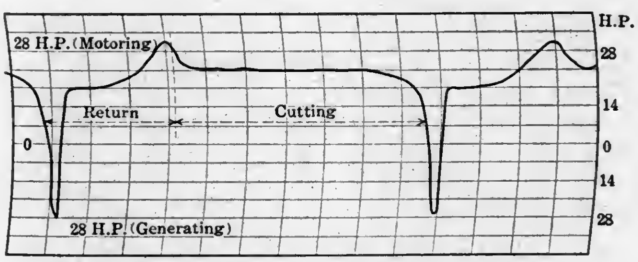


Fig. 5.—Electrical Regenerative Reversing Gear.

Machine, 6 ft. by 6 ft. Planing mild steel 18 ft. long. Cutting speed, 80 ft. per minute. Return, 160 ft. per minute.

regenerative type. This diagram shows the remarkable saving of power on the return stroke due to the action of the regenerative apparatus. The "peak" of the first diagram has become a "pit."

Diagram, Fig. 5, was taken from a machine driven by a reversible motor on the regenerative system. The power regeneration at the end of each cycle is strikingly shown. This machine was working on a long stroke, 18 ft.; the mechanical regenerative machine on a shorter stroke, about 8 ft., allowing for the difference in length of stroke and ratio of cutting to return speeds, and the similarity of diagrams is apparent. These regenerative planing machines, whether mechanical or electrical, represent the best modern practice in the line of driving arrangements.

To realize what can be done by the combination of a quick moving table and an effective feed motion, the spring regenerative planing machine from which the diagrams were taken can plane one square foot per tool per minute, while using a 5/16 in. feed. As the planing machine cuts in a straight line, the pressure on the tool per square inch of cut is probably less than in the lathe. Experiments in this direction are lacking. From 3 h.p. to 4 h.p. will be consumed per pound of steel removed per minute, in the best machines, working under the best conditions. For cast iron 2 h.p. to 3 h.p. per minute will be required per pound of chips.

Many old planing machines are of stout design, and may be speeded up considerably by a comparatively simple alteration in the driving gear. A modern machine, cutting at 60 ft. per minute will require from 25 h.p. to 35 h.p.

Speeds and Powers for High-speed Planers.

Size of Machine. Feet	Cutting Speeds. Feet per Minute.	Return Speed.	Horse-power.
2 × 2	30 to 90	200	7½
3 × 3	30 " 90	200	12½
4 × 4	25 to 75	180	20 to 25
6 × 6	20 to 60	160	30 to 35
8 × 8	20 to 60	140	35 to 40

Machines equipped with motors as above, with a length of stroke equal to 2½ or 3 times the width of the machine, should be capable of taking good cuts on steel on the highest speed. A point in connection with planing machine tools is that the clearance angle may be much less than in a lathe tool. The lathe tool when cutting works in a helical path relatively to the work, consequently the angle of clearance must be more than the angle of the helix. As the planing tool moves in a straight line relative to the work, a clearance angle from 2 deg. to 3 deg. is sufficient, against 5 deg. to 7 deg. for a lathe tool. A minimum clearance angle is of advantage in enabling the tool to withstand the shock of entering work at high speed.

Shaping and Slotting Machines.

These machines are straight-line cutters, like the planing machine, but, in their usual sizes, are not subject to the handicap of the reversal of the rotating parts. Consequently increased speeds are more readily obtainable than in the case of the planing machine. The improvements of recent years have been mostly in the direction of increased handiness. The American type of shaper, where the length of stroke can be adjusted and the ram positioned while the machine is in motion is a case in point. The grouping of operating handles, so that the workman can control all motions of the table from one position, and improved means of quickly adjusting length of stroke and feed in the slotting machine, is another case. The hammer and anvil-like construction of the slotting machine enable it to carry heavy cuts without vibration. The shaper, as a rule, is not adapted for such heavy cuts.

H. J. Brackenbury, in his 1910 paper read at the joint summet meeting of the Institution of Mechanical Engineers and the American Society of Engineers, gives particulars of a 10 in. stroke and 6 in. slotting machine as follows:

Size of Machine Inches.	Strokes per Minute.	Cut to Inches. Length,	Depth.	Feed Inches	Superficial Area covered per Minute Square Inches.	Material Removed per Minute Lbs.
10	45	10	⅝	1/20	22.5	4
6	65	6	⅜	1/20	19.5	2

These cuts were taken in steel without any sign of jar or vibràtion in the machines. Assuming a quick return ratio of 2 to 1, the average cutting speed on the 10 in. stroke is 56 ft. per minute, and on the 6 in. stroke, 49 ft. per minute. The power required would be about 15 h.p. and 7½ h.p., respectively, when taking the cuts mentioned in the tests.

From the belt power of a group of shapers of the American type the following table has been computed:

Length of Stroke Inches	Cutting Strokes	Horse-power per Minute.
14	10 to 130	3
16	7 " 125	4
20	6 " 110	5
24	6 " 100	7½
36	6 " 70	10

The Milling Machine.

Milling is an economic process, especially on repetition work. A large number of milling machines are single purpose tools; that is, designed to do one job only. The speed and feed requirements of a machine for general work are (1) the quickest spindle speed should be fast enough for the smallest cutter used on the machine. (2) The slowest spindle speed should be slow enough for the largest cutter. (3) Every diameter of cutter in ordinary use should have a range of feeds sufficient to enable it to do efficient milling according to its class. A

general machine should, therefore, have an ample range of speeds and feeds, the rate of feed being independent of the spindle speed.

An instructive series of tests were carried out in 1909 by Alfred Herbert, Ltd., Co., Coventry, on one of their standard machines, the weight of which was about 1½ tons. A spiral cutter 3 in. diameter by 6 in. long, with eight teeth, was used at a constant speed of 66 ft. per minute, preliminary experiments having shown this to be a good speed for heavy cutting. The maximum metal removed per horsepower minute was 1.52 cubic in. for cast iron, and .71 cubic in. for mild steel. The maximum total output obtained was 15.23 cubic ft. per minute on cast iron, and 6.27 cubic in. per minute on steel. The greatest output on cast iron was obtained with a cut ⅝ in. deep, at a feed of 9½ in. per minute, from which it might be inferred that on cast iron it pays to take off as much as possible in one cut, whereas on mild steel shallower cuts at quicker feeds might be more economical. The maximum net horsepower used in these tests was 12.3, which indicates a large productive capacity for so small a machine.

In the Transactions of the American Society of Engineers, 1908, tests of a built-up spiral cutter, 8 in. diameter, 18 in. long with inserted blades, are described. This cutter in one test required 96 h.p. and removed mild steel at the rate of 80 lbs. per hour. The speed in this test was 75½ feet per minute, and the feed ⅜ in. deep by 7 in. per minute. It has been computed that 300 h.p. would be required to drive this cutter to its full capacity at from 150 lbs. to 180 ft. per minute. The milling cutter is evidently in advance of the machine.

Tests seem to show that built-up cutters are superior to solid cutters as material removers, owing to the fact that a more acute cutting angle can be obtained, and the construction of the cutter is more favorable to the escape of the cuttings. Milling cutter speeds vary greatly according to the work required of them. Sixty-six feet per minute is probably a good average speed, having regard to durability of the cutter. The feeds may vary from ½ in. to 30 in. per minute in extreme cases. Tests show that in some cases 33 per cent. of the power supplied to the machine is absorbed in driving the feed gear when carrying heavy cuts. It is evident from this that milling machines' spindles should be rigidly supported, and should be as stiff as possible if heavy duty is expected from them.

The Drilling Machine.

The penetrative power of high-speed drills is remarkable; a 1 in. diam. drill has worked at the rate of 18 in. per minute on cast iron and 12 in. per minute on mild steel. These are rates obtained in rigid machines using special drills. In ordinary practice the above rates cannot be kept up for any length of time. Too much attention would be requisite in grinding and keeping the drills in proper condition, besides which there would be an undue proportion of drill breakages. One-half of the above rates is good practice, and it is only on modern high-speed machines that the latter rate can be maintained. Experiments show that a medium peripheral speed and a coarse feed give a smaller power consumption per inch of depth than a high peripheral speed and a fine feed. Drills of high-speed steel possess sufficient torsional strength to stand coarse feeds; coarse feeds increase the drill pressure, hence the necessity for rigid machines and positive feeds if it is required to use high-speed drills economically.

The following table is given by Mr. Dempster Smith. It is based upon a run of 1½ hours without regrinding:

Diameter of Drill.	Feed per Revolution.		Revolutions per Minute.	
	Soft Cast Iron	Soft Steel.	Soft Cast Iron.	Soft Steel.
Inches.	Inch.	Inch.		
¼	1/133	1/160	2560	2820
½	1/160	1/126	900	1000
1	1/84	1/100	320	357
2	1/67	1/79.5	113	127
3	1/58.4	1/69.5	61.5	68.5
4	1/52.8	1/63	40	44.6

Compared with the speeds recommended by twist-drill makers, the above speeds are excessive for the smaller sizes and low for the larger. To take full advantage of high-speed drills, machines of the sensitive type are required for sizes under 1 in. diam., while for sizes from 2 in. to 4 in. diam. stiff and powerful machines are necessary to take advantage of the coarse feeds. More drill breakages are caused by want of rigidity in machines than by high speeds and coarse feeds.

The net power required to drill a 4 in. diam. hole at the feed and speed given in the above table is 9 h.p., when operating on steel. The thrust of a 3 in. diam. drill at 1/50 feed in about 7,600 lbs. when drilling medium steel with the drill in good condition. Tapping can be done at about one-third the speed of drilling.

Boring varies so much in character that every job is a law unto itself. Speeds from 20 ft. to 80 ft. per minute, with feeds from 1/50 in. to ½ in. per revolution, are obtainable in various cases.

Grinding Machines.

Grinding machines, apart from those used in the sharpening of tools, are essentially products of modern machine-shop practice. No well-organized machine shop is complete without a grinding machine of some type, for finishing work which has been roughed in some machine of the lathe, planer, or miller type. Grinding is practically a milling process, the grinding wheel being a cutter with a large number of small teeth, which renew themselves automatically when blunted. As a material remover, the grinding machine is not an economical user of power, but for speed and accuracy of finish, when only a small amount of material is to be removed, it has no rival. Grinding machines are adapted for finishing work of the heaviest class. A machine has been built for grinding shafts up to 3 ft. diam. and 33 ft. long. This machine is driven by three independent motors; the work is rotated by a 16 h.p. motor, the grinding wheel by a 30 h.p. motor, while the saddle which carries the grinding wheel is traversed by a 5 h.p. motor. The three motions, work rotation, wheel rotation, and feed traverse, may be varied independently of each other, an essential condition in a well-designed machine.

The whole question of grinding machine speeds and feeds is so complex that it is impossible to do more than generalize in regard to the same. The speed combinations now generally adopted differ considerably from those which were formerly considered correct practice. The developments have been in the direction of increased wheel speeds, increased feed traverse, and reduced speeds of work rotation.

The wheel speeds vary according to the grit and grade of the wheel, the material worked on, and also its size and condition. The nature of the finish desired has also to be taken into account, and in this way the speeds vary from 4,000 ft. to 6,000 ft. per minute.

The feed traverse in a cylindrical grinder is mainly regulated by the width of the wheel used. The traverse per revolution of the work must be less than the width of the wheel. The depth of cut and the character of the work also affect the feed traverse, which may be anything from 1 in. to 60 in. per minute.

With regard to power required, the writer has no record of exact experiments. One maker of cylindrical grinding machines fits a 5 h.p. motor to a machine using a 20 in. diam. wheel 2 in. wide; another maker recommends a 10 h.p. motor for the same size of wheel. The following table, based on the belt power of Norton standard grinding machines, may be of some value:

Number of Wheels.	Maximum Diameter and Thickness of Wheels. Inches.	Maximum Horse power.
1	12 × 2	2.0
1	30 × 4	9.5
2	6 × 1	1.5
2	10 × 1½	3.0
2	12 × 2	4.0
2	16 × 3	8.0
2	24 × 4	9.5
2	36 × 4	11.0

The machines from which the above table is taken have no feed motion, consequently the whole of the power is available at the wheels. In cylindrical grinders about 50 per cent. extra will be required for work rotation and feed traverse.

As an example of grinding work, a machine with a wheel 24 in. diam. by 2 in. face finishes a shaft rough-turned with a 12 per inch feed, 1/100 in. above size at the bottom of the tool

marks, 4 in. diam., 3 ft. long, in six minutes. A piston rod, 2¾ in. diam., 34 in. long, rough-turned with a 6 per inch feed 1/32 in. above size, is finished in 14 minutes, the speed of the wheel in the latter case being 6,500 ft. per minute, the speed of work rotation 45 ft. per minute, and the feed traverse 8 in. per minute.

NEW DESIGN ROUNDHOUSE SMOKE JACK

In view of the diversified nature of repairs made to locomotives while in the roundhouse, many of which, in particular valve setting, requiring that it shall be frequently moved under its own steam, it becomes necessary to provide a means which will permit of this movement in addition to its primary function of keeping the house free from smoke.

The smoke jacks shown in the accompanying illustration of a concrete roundhouse interior were designed and manufactured by Paul Dickinson, Inc., Chicago, Ill. Several new ideas are embodied in the design, the whole affording an adequate and exceptionally substantial cast iron arrangement. It will be noted that the pitch at the ends of the hood is very steep, this being necessary on account of the great velocity of steam and smoke when the blower is used to fire up the locomotive.

It is impossible for the smoke and steam to choke in the upper part of the hood in the presence of this scientific construction. Since the locomotive stack is not always in the center of the track, arising from the necessity of at times jacking it higher on one side than the other, a wide hood is required, and this desirable feature has been attained in this design through the flared hanging sides of the hood which are added to increase the width so that the smoke from the stack can always be collected.

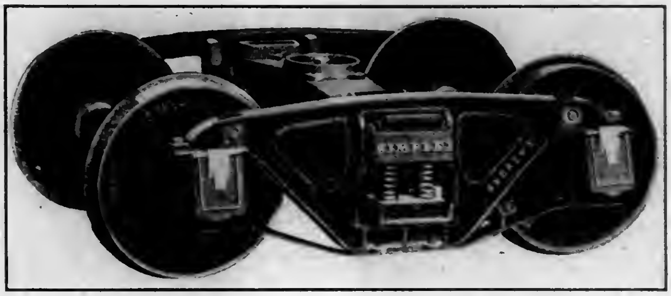
DICKINSON SMOKE JACKS IN A CONCRETE ROUNDHOUSE.

To keep the roundhouse clear of smoke and steam while the locomotives are passing in or out, a ventilator was furnished around the pipe at the roof line, in the instance of the house illustrated. This idea has been found particularly valuable, as it takes care of the smoke at the point most easily handled. To retain the heat in the roundhouse when the smoke jack is not in use a damper was furnished. This is operated by means of a sliding weight or ball connected to the damper in the manner shown, the ball holding the latter in an open or closed position as may be desired.

Plans Have Been Prepared for large new repair shops for the Canadian Pacific Railway at Coquitlam, British Columbia. It is stated that the shops will extend for nearly two miles.

FREIGHT CAR TRUCK OF 70 TONS CAPACITY

The American Steel Foundries exhibited at the Atlantic City Convention a complete freight car truck suitable for use under 70 or 75 ton equipment. This truck, as shown by the accompanying illustration, is of their usual construction, which has been adopted as standard on a number of the large railway



systems. The design is of particular interest in view of the light total weight represented, which is only 8,600 pounds.

The great strength of metal used in the manufacture of the Davis cast steel wheels has made it possible to reduce their weight to about 600 pounds each. If it were possible to make a cast iron wheel which would be suitable for a truck of this capacity such wheels would weigh not less than 850 or 900 pounds each, and rolled steel or steel tired wheels would weigh even more. Therefore in the use of the Davis wheels a reduction in weight of 1,000 pounds per truck, or 2,000 pounds per car is obtained. The Andrews side frames weigh 500 pounds each, or 1,000 pounds per truck, a saving of at least 250 pounds per truck, or 500 pounds per car, over arch bar construction. The Simplex bolster weighs about 950 pounds, the axles about the same, and the journal boxes 125 pounds each.

In a truck of this capacity any saving which can be effected in its weight is not only important so far as the cost of hauling the extra weight is concerned, but has an indirect value in lowering the cost of track and bridge maintenance. Different railways have various ways of figuring their actual cost of hauling one ton one mile, but there are few roads which figure the cost at less than ¼ cent per ton mile.

If computed on this basis, and using an estimated figure for the probable mileage which the car will make during its life, the saving in weight of 2,500 pounds per car as effected in this example, results in some surprisingly large figures, which it is difficult to disregard. When this result is multiplied by the number of high capacity cars in service the sum total is amazing.

The truck tests recently made at the Granite City plant of the American Steel Foundries* show the necessity for a rigid fastening between the two side frames, to hold the truck square and prevent one side frame getting ahead of the other one when the truck is passing around curves. In this truck the two side frames are held rigidly at right angles with the axles by a heavy channel spring plank, which is riveted to each frame with 10 rivets.

A loose truck, or one with a spring plank connection which permits the wheels on one side to get ahead of the others, allows the truck to become skewed in passing around curves, and it runs in this condition for a considerable length of time after the truck gets onto a tangent. This causes the wheels on the outer side of the curve to grind against the rail, increasing the resistance of the truck and decreasing by a corresponding amount the hauling capacity of the motive power. Reduced to pounds per ton, the Granite City tests showed a resistance of 38.33 pounds on a 22-degree curve for a loose truck, while for a square truck it was only 24.68 pounds, a difference in favor of the square truck of 13.65 pounds, or 35.6 per cent. To push a loose truck around a 22-degree curve required the combined efforts of from 5 to 7 men, while to push a square truck around the same curve only two men were required.

* See American Engineer, May, 1911, page 192.

general machine should, therefore, have an ample range of speeds and feeds, the rate of feed being independent of the spindle speed.

An instructive series of tests were carried out in 1909 by Alfred Herbert, Ltd., Co., Coventry, on one of their standard machines, the weight of which was about 1½ tons. A spiral cutter 3 in. diameter by 6 in. long, with eight teeth, was used at a constant speed of 60 ft. per minute, preliminary experiments having shown this to be a good speed for heavy cutting. The maximum metal removed per horsepower minute was 1.52 cubic in. for cast iron, and .71 cubic in. for mild steel. The maximum total output obtained was 15.23 cubic ft. per minute on cast iron, and 6.27 cubic in. per minute on steel. The greatest output on cast iron was obtained with a cut 5/8 in. deep, at a feed of 9½ in per minute, from which it might be inferred that on cast iron it pays to take off as much as possible in one cut, whereas on mild steel shallower cuts at quicker feeds might be more economical. The maximum net horsepower used in these tests was 12.3, which indicates a large productive capacity for so small a machine.

In the Transactions of the American Society of Engineers, 1908, tests of a built up spiral cutter, 8 in. diameter, 18 in. long with inserted blades, are described. This cutter in one test required 66 h.p. and removed mild steel at the rate of 80 lbs. per hour. The speed in this test was 75½ feet per minute, and the feed 5/8 in. deep by 7 in. per minute. It has been computed that 300 h.p. would be required to drive this cutter to its full capacity at from 150 lbs. to 180 ft. per minute. The milling cutter is evidently in advance of the machine.

Tests seem to show that built up cutters are superior to solid cutters as material removers, owing to the fact that a more acute cutting angle can be obtained, and the construction of the cutter is more favorable to the escape of the cuttings. Milling cutter speeds vary greatly according to the work required of them. Sixty six feet per minute is probably a good average speed, having regard to durability of the cutter. The feeds may vary from ½ in. to 30 in. per minute in extreme cases. Tests show that in some cases 33 per cent. of the power supplied to the machine is absorbed in driving the feed gear when carrying heavy cuts. It is evident from this that milling machines' spindles should be rigidly supported, and should be as stiff as possible if heavy duty is expected from them.

The Drilling Machine.

The penetrative power of high speed drills is remarkable; a 1 in. diam. drill has worked at the rate of 18 in. per minute on cast iron and 12 in per minute on mild steel. These are rates obtained in rigid machines using special drills. In ordinary practice the above rates cannot be kept up for any length of time. Too much attention would be requisite in grinding and keeping the drills in proper condition, besides which there would be an undue proportion of drill breakages. One-half of the above rates is good practice, and it is only on modern high-speed machines that the latter rate can be maintained. Experiments show that a medium peripheral speed and a coarse feed give a smaller power consumption per inch of depth than a high peripheral speed and a fine feed. Drills of high-speed steel possess sufficient torsional strength to stand coarse feeds; coarse feeds increase the drill pressure, hence the necessity for rigid machines and positive feeds if it is required to use high speed drills economically.

The following table is given by Mr. Dempster Smith. It is based upon a run of 1½ hours without regrinding:

Diameter of Drill.	Feed per Revolution.		Revolutions per Minute.	
	Soft Cast Iron	Soft Steel.	Soft Cast Iron.	Soft Steel.
Inches.	Inch	Inch.		
¼	1/133	1/160	2560	2820
½	1/160	1/126	900	1000
1	1/84	1/100	320	357
2	1/67	1/79.5	113	127
3	1/58.1	1/69.5	61.5	68.5
4	1/52.8	1/63	40	41.6

Compared with the speeds recommended by twist-drill makers, the above speeds are excessive for the smaller sizes and low for the larger. To take full advantage of high-speed drills, machines of the sensitive type are required for sizes under 1 in. diam., while for sizes from 2 in. to 4 in. diam. stiff and powerful machines are necessary to take advantage of the coarse feeds. More drill breakages are caused by want of rigidity in machines than by high speeds and coarse feeds.

The net power required to drill a 4 in. diam. hole at the feed and speed given in the above table is 9 h.p., when operating on steel. The thrust of a 3 in. diam. drill at 1/50 feed in about 7,600 lbs. when drilling medium steel with the drill in good condition. Tapping can be done at about one-third the speed of drilling.

Boring varies so much in character that every job is a law unto itself. Speeds from 20 ft. to 80 ft. per minute, with feeds from 1/50 in. to ½ in. per revolution, are obtainable in various cases.

Grinding Machines.

Grinding machines, apart from those used in the sharpening of tools, are essentially products of modern machine-shop practice. No well-organized machine shop is complete without a grinding machine of some type, for finishing work which has been roughed in some machine of the lathe, planer, or miller type. Grinding is practically a milling process, the grinding wheel being a cutter with a large number of small teeth, which renew themselves automatically when blunted. As a material remover, the grinding machine is not an economical user of power, but for speed and accuracy of finish, when only a small amount of material is to be removed, it has no rival. Grinding machines are adapted for finishing work of the heaviest class. A machine has been built for grinding shafts up to 3 ft. diam. and 33 ft. long. This machine is driven by three independent motors; the work is rotated by a 16 h.p. motor, the grinding wheel by a 30 h.p. motor, while the saddle which carries the grinding wheel is traversed by a 5 h.p. motor. The three motions, work rotation, wheel rotation, and feed traverse, may be varied independently of each other, an essential condition in a well designed machine.

The whole question of grinding machine speeds and feeds is so complex that it is impossible to do more than generalize in regard to the same. The speed combinations now generally adopted differ considerably from those which were formerly considered correct practice. The developments have been in the direction of increased wheel speeds, increased feed traverse, and reduced speeds of work rotation.

The wheel speeds vary according to the grit and grade of the wheel, the material worked on, and also its size and condition. The nature of the finish desired has also to be taken into account, and in this way the speeds vary from 4,000 ft. to 6,000 ft. per minute.

The feed traverse in a cylindrical grinder is mainly regulated by the width of the wheel used. The traverse per revolution of the work must be less than the width of the wheel. The depth of cut and the character of the work also affect the feed traverse, which may be anything from 1 in. to 60 in. per minute.

With regard to power required, the writer has no record of exact experiments. One maker of cylindrical grinding machines fits a 5 h.p. motor to a machine using a 20 in. diam. wheel 2 in. wide; another maker recommends a 10 h.p. motor for the same size of wheel. The following table, based on the belt power of Norton standard grinding machines, may be of some value:

Number of Wheels.	Maximum Diameter and Thickness of Wheels. Inches.	Maximum Horse power.
1	12 × 2	2.0
1	30 × 4	9.5
2	6 × 1	1.5
2	10 × 1½	3.0
2	12 × 2	4.0
2	16 × 3	8.0
2	24 × 4	9.5
2	36 × 4	11.0

The machines from which the above table is taken have no feed motion, consequently the whole of the power is available at the wheels. In cylindrical grinders about 50 per cent. extra will be required for work rotation and feed traverse.

As an example of grinding work, a machine with a wheel 24 in. diam. by 2 in. face finishes a shaft rough-turned with a 12 per inch feed, 1/100 in. above size at the bottom of the tool

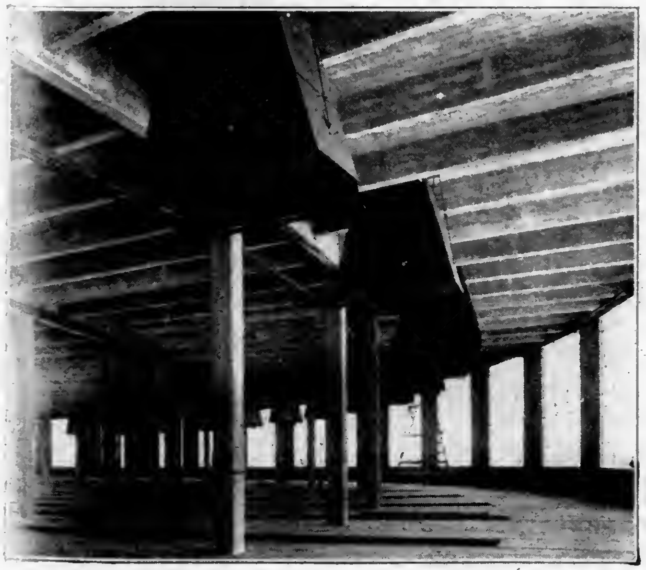
ks. 4 in. diam., 3 ft. long, in six minutes. A piston rod, in. diam., 34 in. long, rough-turned with a 6 per inch feed in. above size, is finished in 14 minutes, the speed of the l in the latter case being 6,500 ft. per minute, the speed ork rotation 45 ft. per minute, and the feed traverse 8 in. minute.

NEW DESIGN ROUNDHOUSE SMOKE JACK

view of the diversified nature of repairs made to locomo ves while in the roundhouse, many of which, in particular setting, requiring that it shall be frequently moved under wn steam, it becomes necessary to provide a means which permit of this movement in addition to its primary function of keeping the house free from smoke.

he smoke jacks shown in the accompanying illustration of ncrete roundhouse interior were designed and manufactured Paul Dickinson, Inc., Chicago, Ill. Several new ideas are odied in the design, the whole affording an adequate and ptionally substantial cast iron arrangement. It will be d that the pitch at the ends of the hood is very steep, this g necessary on account of the great velocity of steam and ke when the blower is used to fire up the locomotive.

is impossible for the smoke and steam to choke in the upper of the hood in the presence of this scientific construction. e the locomotive stack is not always in the center of the k, arising from the necessity of at times jacking it higher ne side than the other, a wide hood is required, and this rable feature has been attained in this design through the d hanging sides of the hood which are added to increase width so that the smoke from the stack can always be col d.



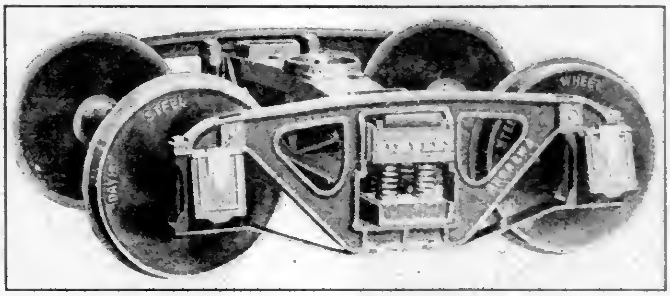
DICKINSON SMOKE JACKS IN A CONCRETE ROUNDHOUSE.

o keep the roundhouse clear of smoke and steam while the motives are passing in or out, a ventilator was furnished und the pipe at the roof line, in the instance of the house strated. This idea has been found particularly valuable, as akes care of the smoke at the point most easily handled. To ain the heat in the roundhouse when the smoke jack is not use a damper was furnished. This is operated by means a sliding weight or ball connected to the damper in the nner shown, the ball holding the latter in an open or closed ition as may be desired.

PLANS HAVE BEEN PREPARED for large new repair shops for e Canadian Pacific Railway at Coquitlam, British Columbia. t is stated that the shops will extend for nearly two miles.

FREIGHT CAR TRUCK OF 70 TONS CAPACITY

The American Steel Foundries exhibited at the Atlantic City Convention a complete freight car truck suitable for use under 70 or 75 ton equipment. This truck, as shown by the accompanying illustration, is of their usual construction, which has been adopted as standard on a number of the large railway systems. The design is of particular interest in view of the light total weight represented, which is only 8,600 pounds.



The great strength of metal used in the manufacture of the Davis cast steel wheels has made it possible to reduce their weight to about 600 pounds each. If it were possible to make a cast iron wheel which would be suitable for a truck of this capacity such wheels would weigh not less than 850 or 900 pounds each, and rolled steel or steel tired wheels would weigh even more. Therefore in the use of the Davis wheels a reduction in weight of 1,000 pounds per truck, or 2,000 pounds per car is obtained. The Andrews side frames weigh 500 pounds each, or 1,000 pounds per truck, a saving of at least 250 pounds per truck, or 500 pounds per car, over arch bar construction. The Simplex bolster weighs about 950 pounds, the axles about the same, and the journal boxes 125 pounds each.

In a truck of this capacity any saving which can be effected in its weight is not only important so far as the cost of hauling the extra weight is concerned, but has an indirect value in lowering the cost of track and bridge maintenance. Different railways have various ways of figuring their actual cost of hauling one ton one mile, but there are few roads which figure the cost at less than ½ cent per ton mile.

If computed on this basis, and using an estimated figure for the probable mileage which the car will make during its life, the saving in weight of 2,500 pounds per car as effected in this example, results in some surprisingly large figures, which it is difficult to disregard. When this result is multiplied by the number of high capacity cars in service the sum total is amazing.

The truck tests recently made at the Granite City plant of the American Steel Foundries* show the necessity for a rigid fastening between the two side frames, to hold the truck square and prevent one side frame getting ahead of the other one when the truck is passing around curves. In this truck the two side frames are held rigidly at right angles with the axles by a heavy channel spring plank, which is riveted to each frame with 10 rivets.

A loose truck, or one with a spring plank connection which permits the wheels on one side to get ahead of the others, allows the truck to become skewed in passing around curves, and it runs in this condition for a considerable length of time after the truck gets onto a tangent. This causes the wheels on the outer side of the curve to grind against the rail, increasing the resistance of the truck and decreasing by a corresponding amount the hauling capacity of the motive power. Reduced to pounds per ton, the Granite City tests showed a resistance of 38.33 pounds on a 22-degree curve for a loose truck, while for a square truck it was only 24.68 pounds, a difference in favor of the square truck of 13.65 pounds, or 35.6 per cent. To push a loose truck around a 22-degree curve required the combined efforts of from 5 to 7 men, while to push a square truck around the same curve only two men were required.

* See AMERICAN ENGINEER, May, 1911, page 192.

HEAVY HIGH DUTY PACIFIC TYPE LOCOMOTIVES

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY.

An order of ten Pacific type locomotives has recently been delivered to the Minneapolis, St. Paul & Sault Ste. Marie Railway by the American Locomotive Company, one of which is illustrated herewith. These engines are representative of the latest development of the modern high duty passenger locomotive. The design which was prepared by the builders represents their most approved practice for engines of this class, embodying as it does in one engine practically all the new features which have been successfully applied by them during the past two years to other engines of a similar class. They constitute the latest of an interesting series of design of Pacific type locomotives, each one heavier and more powerful than the preceding.

NEW 4-6-2 LOCOMOTIVE FOR THE SOO LINE.

The story of this development on the Soo Line is told by the following table, and is typical of what other roads have had to do in their effort to meet increased requirements or to improve service.

Year.	1904-1909.	1910.	1911.
Weight on driving wheels, lbs......	131,000	147,500	158,000
Total weight, lbs....................	206,000	221,000	258,000
Cylinders diameter and stroke, in....	20 x 26	24½ x 26	25 x 26
Driving wheels, diameter, in.........	69	69	75
Boiler pressure, pounds per sq. in....	200	160	180
Total heating surface, sq. ft..	2,877.3	2,876	3,522
Superheater heating surface, sq. ft...	......	515	805
Grate area, sq. ft....................	43.9	47	52.8
Tractive power, lbs.................	25,600	30,800	33,200

During seven years, from 1904 to 1911, there has been an increase in weight of 52,000 pounds, and 7,600 pounds in tractive power. Also, the design, which a year ago was considered adequate to meet the requirements has been superseded by one 37,000 pounds heavier and having 2,400 pounds more tractive power.

Part of this present order will be used on the Chicago division between Chicago and Minneapolis, and the remainder on the Soo division. The former division is over very rolling country. In the 460 miles between Chicago and Trout Brook Junction there is only about 85 miles of level track. In going north from Chicago there are 191 miles of ascending grades, of which about 24 miles are at least 1 per cent., the maximum being 1.21 per cent. The longest ascent going in this direction is between Gillis Landing and Custer, a distance of 31.6 miles, in which there is a rise of 414 feet. Traveling south there are 184 miles of ascending grade, of which about 16 miles is at least .8 per cent., the maximum being 1.2 per cent.

Their fast trains have a schedule from Chicago to Minneapolis of 14 hours and 25 minutes (including stops) or an average speed of 33 miles per hour, while in the other direction the schedule time is 14 hours and 35 minutes, or 10 minutes slower, giving an average speed of 32.6 miles per hour. Present traffic conditions necessitate running more cars on their through limited trains, and in ordering these heavier engines it is the purpose of the Soo Line management to increase these trains to 12 cars and operate them on the same schedule as is now in force for the lighter trains. Definite limits are set for the maximum speed on the descending grades, so that in order to maintain the schedule these new engines will have to handle 12 cars on the up grades at the same speed as the present type handles the lighter trains.

Like the class which they supersede, the engines here illustrated are equipped with fire tube superheaters of the side header type. Their weight of 258,000 pounds and tractive power of 33,200 pounds places them among the most powerful engines of their class. Among the new features embodied in this design will be noticed the steam pipe arrangement having an outside connection with the cylinders. A similar arrangement was applied by these builders to a recent order of Pacific type locomotives built for the New York Central, and in a number of other instances. This arrangement provides more free area in the smoke box under the table plate for the waste gases than the ordinary arrangement. It also greatly simplifies and strengthens the coring of the cylinder casting and, taken as a whole, provides for the simplest and most direct passage of steam from the superheater header to the steam chest, and one open to inspection for its entire length.

Another example of the builder's latest practice is the design of the Walschaert valve gear crosshead and guide. The guide is an integral part of the valve chamber head and is centered by the bore of the valve chamber, thus insuring absolute alignment of the crosshead and valve stem. The guides are of the four-bar type. Each of the upper guides is formed of a separate piece bolted to its corresponding lower guide, and between the two pieces is a liner plate which makes it possible to easily adjust the guides for any wear.

The trailing truck is the builder's improved design of outside bearing radial truck with floating spring seat yoke, which has been successfully applied to a large number of recent Pacific type locomotives built by them. This type of truck is of a very much simpler construction than their older design and saves a considerable amount of weight. Compared with their former truck of the same class there is a difference of from 2,500 to 300 pounds in favor of the design here applied. Extended rods are used for both pistons and valves following the latest practice with superheated steam.

Throughout the whole design there is evidence of special attention in working out the details to keeping the weight of the parts of the engine and running gear as low as possible, consistent with strength in order to provide the maximum boiler capacity within the given total weight of engine.

The general dimensions and ratios are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Bit. Coal
Tractive power	33,200 lbs.
Weight in working order	258,000 lbs.
Weight on drivers	158,000 lbs.
Weight of engine and tender in working order	401,200 lbs.
Wheel base, driving	13 ft. 6 in.
Wheel base, total	34 ft. 7 in.
Wheel base, engine and tender	66 ft. 2¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.75
Total weight ÷ by tractive effort	7.76
Tractice effort × diam. drivers ÷ heating surface	706.98
Total heating surface ÷ grate area	66.89
Fire box heating surface ÷ total heating surface	5.87
Weight on drivers ÷ total heating surface	44.86
Total weight ÷ total heating surface	73.25
CYLINDERS.	
Kind	Simple
Diameter and stroke	25 x 26 in.

VALVES.	
Kind	Piston
Diameter	14 in.
Greatest travel	6½ in.
Outside lap	1⅛ in.
Inside clearance	⅛ in.
Lead in full gear	F 1/16, B 7/16 in.
WHEELS.	
Driving, diameter over tires	75 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	10 x12 in.
Engine truck wheels, diameter	36 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	50 in.
Trailing truck journals	8 x 14 in.
BOILER.	
Style	Ext. Wagon Top
Working pressure	180 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	108⅛ x 70¼ in.
Firebox plates, thickness	S. & B. ⅜ in., F. ½ in., C. ⅜ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	217—2 in.
Tubes, length	21 ft.
Heating surface, tubes	3,315 sq. ft.
Heating surface, firebox	207 sq. ft.
Heating surface, total	3,522 sq. ft.
Superheater heating surface	805 sq. ft.
Great area	52.8 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	15 ft. 6 in.
TENDER.	
Frame	Steel channels
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,500 gal.
Coal capacity	12 tons

COMMUTATING POLE MOTOR OF NEW TYPE

The severe service that electric motors are called upon to perform in many industrial power applications, and the consequent necessity for reliability and efficient all-day operation, requires the use of machines possessing exceptionally good commutation, overload and heating characteristics, combined with great mechanical ruggedness. The type "CVC" commutating pole motor, just brought out by the General Electric Company, has been specifically designed to meet such requirements.

The reason for the commutating pole design may be readily understood if it be remembered that sparking under the brush of a non-commutating pole D. C. machine is almost wholly due to the absence of a magnetic field, automatic in action and of sufficient intensity to reverse the armature coils successively

3-HORSEPOWER "CVC" MOTOR.

short-circuited as corresponding segments pass under the brushes. The commutating poles of "CVC" motors are connected in series one with another, and also with the armature; their magnetizing power is, therefore, in proportion to the armature current, and may consequently be employed to compensate for armature reaction, allowing sparkless commutation over wide ranges of load and under adverse conditions of operation. In addition to the above, commutating pole motors allow a wider range of speed control by field than is permitted with motors of non-commutating pole design.

Internal ventilation is secured by a very simple, rigid and durable form of fan mounted on the armature shaft within the

"CVC" MOTOR WITH BELT TIGHTENER.

pulley end bearing head. This fan, while consuming a negligible amount of energy, insures cool operation under very severe conditions of temperature and load. Internal ventilation has been advantageously applied to transformers, motor generator sets, etc., for a number of years. A similar application in motor practice is entirely logical, natural, and in step with the most advanced engineering practice. The main field coils are wound on strong horn fibre spools, amply insulated with pressboard, mica, varnished cambric, etc., to insure freedom from breakdown under possible excess potential strains. The windings are rendered moisture-proof by thorough impregnation with a special insulating compound. Before final assembly the coils are armor-wound with a single layer of enamel-covered wire, serving the double purpose of protecting the active windings from mechanical injury and assisting to a higher degree of heat radiation. The commutating poles are wound with rectangular copper wire, the coils being assembled on horn fibre spools, which thoroughly insulate the coils from the pole pieces.

Special pains have been taken to so design the commutator that complete immunity will exist from loose or "high" bars. The commutator bars are insulated from one another and from the commutator shell by selected sheet mica, micrometer gauged to a uniform thickness and of proper hardness to wear down evenly with the copper. The outer corners of the segments are rounded to prevent chipping of the mica and the inner edges are notched out to prevent short-circuiting between the bars. There are small grooves in both the flat sides of the copper segments which serve, when the commutator is hydraulically pressed in its assembly ring, to firmly anchor the mica insulating segments, thus avoiding the possibility of high mica.

The bearing heads being interchangeable, the relation of the terminal block to the commutator and pulley end heads may be shifted by removing the heads, turning the armature end for end, and finally replacing the heads to correspond with the reversed armature position. It is thus possible to have the terminal block accessible under varying conditions of installation. The bearing linings are large, and thorough lubrication is ensured by the use of heavy oil rings of generous cross section. All bearing brackets and frames are drilled and tapped symmetrically so that motors may be readily arranged for side wall or ceiling suspension by turning the bearing heads 90° or 180° respectively with relation to the frame.

Good Castings do not Depend upon the mixture of metals composing them, but upon foundry practice. With the right foundry practice good castings may be made of any mixture.

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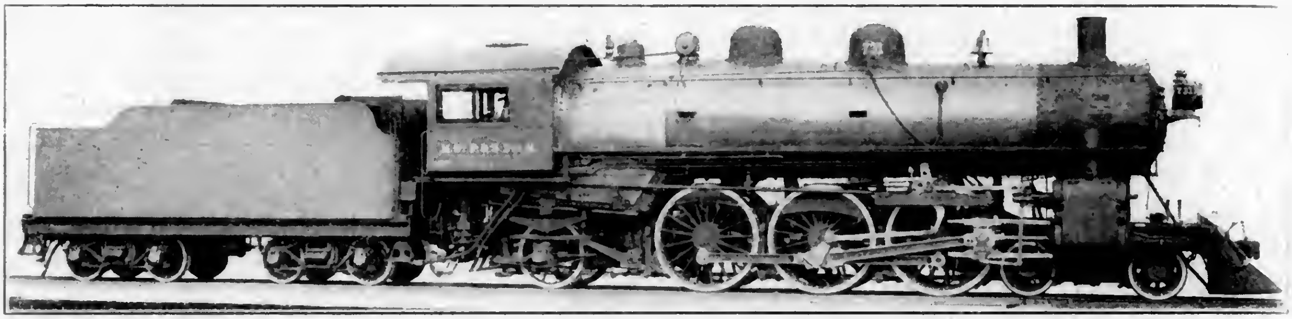

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Wheel base, engine and tender..66 ft. 2¼ in

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...le clearance	⅛ in.
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WHEELS.

...ving, diameter over tires	75 in.
...ving, thickness of tires	3½ in.
...ving journals, main, diameter and length	10½ x 12 in.
...ving journals, others, diameter and length	10 x12 in.
...ne truck wheels, diameter	36 in.
...ne truck, journals	6 x 12 in.
...ling truck wheels, diameter	50 in.
...ling truck journals	8 x 14 in.

BOILER.

...	Ext. Wagon Top
...king pressure	180 lbs.
...ide diameter of first ring	72 in.
...box, length and width	108⅛ x 70¼ in.
...box plates, thickness	S. & B. ⅜ in., F. ½ in., C. ⅜ in.
...box, water space	4½ in.
...s, number and outside diameter	217—2 in.
...s, length	21 ft.
...ting surface, tubes	3,315 sq. ft.
...ting surface, firebox	207 sq. ft.
...ting surface, total	3,522 sq. ft.
...perheater heating surface	805 sq. ft.
...t area	52.8 sq. ft.
...kestack, diameter	18 in.
...kestack, height above rail	15 ft. 6 in.

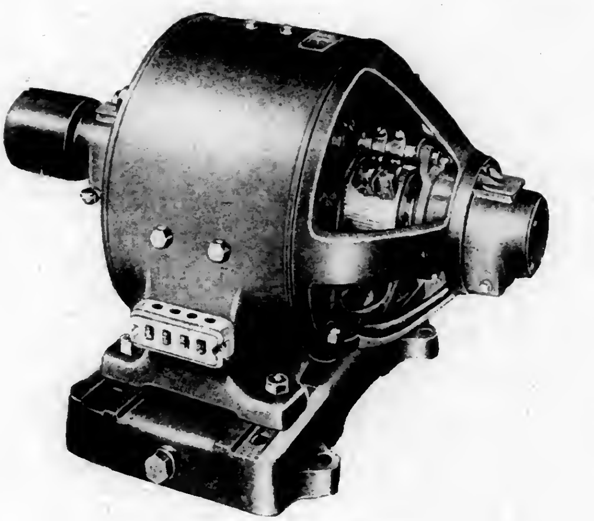
TENDER.

...me	Steel channels
...ls, diameter	36 in.
...nals, diameter and length	5½ x 10 in.
...ater capacity	7,500 gal.
...l capacity	12 tons

COMMUTATING POLE MOTOR OF NEW TYPE

The severe service that electric motors are called upon to per-...rm in many industrial power applications, and the consequent ...ssity for reliability and efficient all-day operation, requires ...e use of machines possessing exceptionally good commutation, ...rload and heating characteristics, combined with great me-...nical ruggedness. The type "CVC" commutating pole motor, ...t brought out by the General Electric Company, has been ...ecifically designed to meet such requirements.

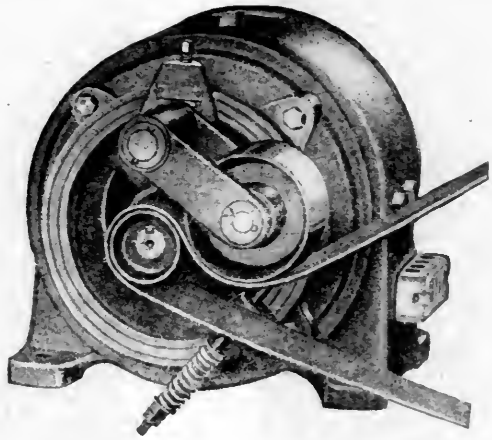
The reason for the commutating pole design may be readily ...derstood if it be remembered that sparking under the brush ...a non-commutating pole D. C. machine is almost wholly due ...the absence of a magnetic field, automatic in action and of ...ficient intensity to reverse the armature coils successively



3-HORSEPOWER "CVC" MOTOR.

...ort-circuited as corresponding segments pass under the ...rushes. The commutating poles of "CVC" motors are con-...ected in series one with another, and also with the armature; ...heir magnetizing power is, therefore, in proportion to the arma-...ure current, and may consequently be employed to compensate ...or armature reaction, allowing sparkless commutation over ...wide ranges of load and under adverse conditions of operation. In addition to the above, commutating pole motors allow a wider range of speed control by field than is permitted with motors of non-commutating pole design.

Internal ventilation is secured by a very simple, rigid and durable form of fan mounted on the armature shaft within the



"CVC" MOTOR WITH BELT TIGHTENER.

pulley end bearing head. This fan, while consuming a negligible amount of energy, insures cool operation under very severe conditions of temperature and load. Internal ventilation has been advantageously applied to transformers, motor generator sets, etc., for a number of years. A similar application in motor practice is entirely logical, natural, and in step with the most advanced engineering practice. The main field coils are wound on strong horn fibre spools, amply insulated with pressboard, mica, varnished cambric, etc., to insure freedom from break-down under possible excess potential strains. The windings are rendered moisture-proof by thorough impregnation with a spe-cial insulating compound. Before final assembly the coils are armor-wound with a single layer of enamel-covered wire, serv-ing the double purpose of protecting the active windings from mechanical injury and assisting to a higher degree of heat radi-ation. The commutating poles are wound with rectangular cop-per wire, the coils being assembled on horn fibre spools, which thoroughly insulate the coils from the pole pieces.

Special pains have been taken to so design the commutator that complete immunity will exist from loose or "high" bars. The commutator bars are insulated from one another and from the commutator shell by selected sheet mica, micrometer gauged to a uniform thickness and of proper hardness to wear down evenly with the copper. The outer corners of the segments are rounded to prevent chipping of the mica and the inner edges are notched out to prevent short circuiting between the bars. There are small grooves in both the flat sides of the copper segments which serve, when the commutator is hydraulically pressed in its assembly ring, to firmly anchor the mica insulating segments, thus avoiding the possibility of high mica.

The bearing heads being interchangeable, the relation of the terminal block to the commutator and pulley end heads may be shifted by removing the heads, turning the armature end for end, and finally replacing the heads to correspond with the re-versed armature position. It is thus possible to have the ter-minal block accessible under varying conditions of installation. The bearing linings are large, and thorough lubrication is en-sured by the use of heavy oil rings of generous cross section. All bearing brackets and frames are drilled and tapped sym-metrically so that motors may be readily arranged for side wall or ceiling suspension by turning the bearing heads 90° or 180° respectively with relation to the frame.

GOOD CASTINGS DO NOT DEPEND upon the mixture of metals composing them, but upon foundry practice. With the right foundry practice good castings may be made of any mixture.

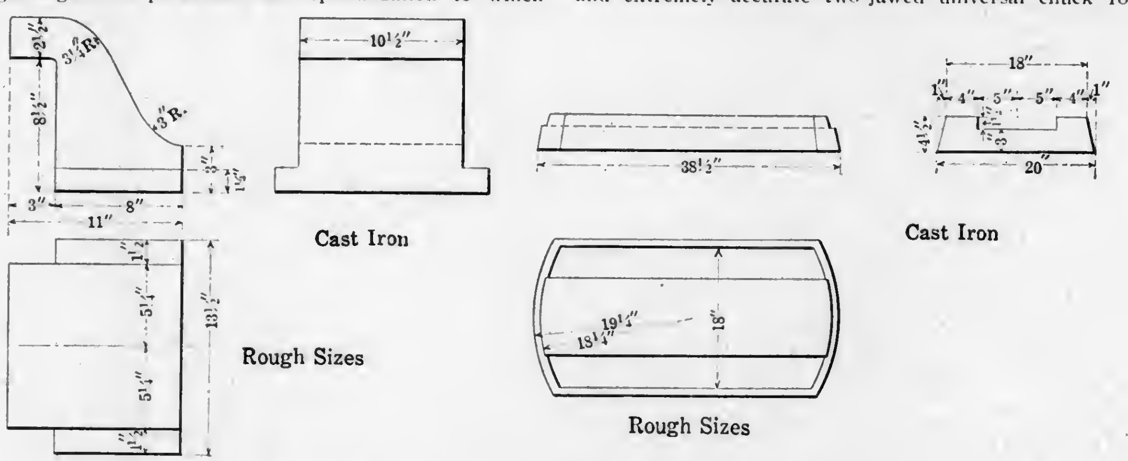
BORING LOCOMOTIVE DRIVING BOXES.

Charles D. Chandler.

While the accomplishment of this operation is as old as the locomotive industry, and taken in a number of different shops, would likely have as many slightly various methods, relative to size, either securing same by bolting the box to the face plate of an engine lathe, horizontal bar, or merely clamping the box on a vertical mill table, irrespective of any fixed accuracy in setting.

FIG. 1.

FIG. 2.



DETAILS OF CHUCK, ON LEFT, AND BEDPLATE ON THE RIGHT.

The high degree of perfection and specialization to which machine tools and steel making has arrived, would seem naturally to suggest the application of the most expeditious and accurate in present-day shop practice. In considering perfecting the development of any kind of work results sometimes fall short of expectations for lack of correct and ample facilities. True also under some policies of supervision, is the fact that fear often exceeds liberality in an original tryout on any job, resulting in establishing a general under capacity, whereas, taking an operation of daily occurrence and increasing demand, almost any reasonable expenditure to the point of momentary extravagance, would eventually justify the first cost.

Having determined on an ideal result, it is as easy in point of manipulation, irrespective of magnitude, to chuck a modern driving box as it is to chuck a rod bushing, cylinder or piston head or perform any other of the most familiar operations. With the aid of the accompanying illustrations and line sketches a clear understanding may be obtained of a most efficient, rigid and extremely accurate two-jawed universal chuck for boring and facing driving boxes on a vertical boring mill. The size and make of machine to which the following refers, and the figures are readily adaptable, is a 42-in. Bullard rapid production type.

In figures 1, 2 and 3, which are almost self-explanatory, can be seen the open chuck, top and bottom views of box in two

working positions, manner of handling tools for same. The line drawing gives working size dimensions of castings for the chuck on the left and its bedplate on the right, and as occasion suggests could be slightly altered to suit any local condition, style of equipment or mill. Mentionable features of merit about this device is an universal movement and liberal contact surfaces of the chuck jaws, 40 or 50 square inches.

Having predetermined the amount to bore out of the crown of the brass, either old or new bearings, it is only necessary to push the box into the chuck a sufficient distance that the finish cut will be on a radius half the diameter of the journal measured from the central point in the chuck base. also an easy and accurate way to set a box so the crown will be sure to true up full length of bore. Noting figure 2 left side rapid traverse head into position for facing babbitt lateral to flange thickness, accomplished in a few minutes and head withdrawn, a combination square is then tried on the new face at the crown surface shows whether metal is "full" or "scant" at bottom of bore. The right head with boring bar is run into center position over mill table, measuring from the bar one-half the journal size less one-half the diameter of bar, will give a point to where the crown surface should be moved to make the cut true up. Aside from finding the point to where the crown cut will run it is quite apparent that all laying out is entirely eliminated.

The little levers seen fulcrumed midway on the outside of both chuck jaws also extend into and overlap the lower box flanges. Small pieces of blocking are used under the inside ends of these levers and the vertical security is assured by screwing out on the small inverted screws pivoted into the outside ends of the levers, thus forcing the whole box down onto the three-point parallel strips on the chuck base. In machining the bedplate it is well to leave a central boss projecting from the bottom which will drop into the spindle hole in the mill table. A right and left double-ended screw relieved of thread in center and square shouldered up against a smooth-bored split anchor plate centrally secured lengthwise of the bedplate, provides amply for thrust of the jaws. Right and left-hand brass nuts are in the base of the chuck jaws easily accessible in case of replacement and repair. As this whole arrangement is self-contained, removing and replacing it does not affect its accuracy in the slightest degree, and with equal advantage rough box castings can be handled for first machining, facing sides, dovetailing for babbitt grooves, etc.

FIG. 3.

To the reader the question may arise of handling and boring the cellars, journal clearance, etc. In figure 3 shows the cellar removed or rather purposely omitted as an advantage in showing up view of the boring bar—also the practical advantage has proven more satisfactory in handling the cellar boring on horizontal bar; having previously tried the cellars in position, depth of cut is easily located and tools used more suited to the different metals.

PECULIARITIES OF WHITE METAL ALLOYS

Comparatively little has been written about babbitt metals and white metal alloys, and that little is of such a character and so detached that only the experienced can extract any value from such articles and they give none of the finer points of manufacturing so essential to the production of genuinely good bearing metals. The high-grade commercial alloys have been developed gradually, and the secrets which impart to such metals their special value are carefully guarded and it is a mistaken idea that maximum results can be obtained, merely by melting down and mixing together various proportions of metals.

The best grade of solder is composed of equal parts of tin and lead. The fusing point of tin is 446 degrees Fahr. and of lead 619 deegrees Fahr., and the mean arithmetic fusing point of this mixture is 532 degrees Fahr., but as a matter of fact solder fuses at 370 degrees Fahr., which is much under even the lowest constituent of the mass. Despite the general knowledge of this fact, babbitts are frequently found closely approximating solder formulas, and although such metals will stand the ordinary physical tests for hardness, toughness, peening, etc., they are highly susceptible to frictional heat, and therefore are liable to soften and squash out of the box at a comparatively low temperature.

Spelter alloys (white brass) also present some peculiar features. When in a cold state it gives every indication of being an ideal bearing metal, being hard, tough, ductile, and peens perfectly, but woe betide the bearing lined with this mixture when the temperature reaches around 300 degrees Fahr. When it does let down there are no halfway measures about it, as it loses all atomic cohesion, and it can be pulverized with a lead pencil. This peculiar quality of white brass is generally known, and its use is usually confined to bearings where the service is intermittent, and not likely to create much frictional heat. It has also had a certain vogue on steamships where the temperature can be kept down with streams of water running over the bearings.

Perhaps the most remarkable of all the white metal alloys is the mixture used for fusible plugs. It is composed of bismuth, 507 degrees Fahr.; cadmium, 610 degrees Fahr., and tin, 446 degrees Fahr., and the mean arithmetic fusing point is higher even than solder, but if this composition were moulded into say the form of a spoon, it would give evidence in weight, strength and appearance of being a useful table implement, and yet it would melt in hot water. The knowledge of many such facts, and then some more, are requisite as a preliminary start to equip a person to produce even a most ordinary grade of babbitt metal that is properly made and evenly balanced. A person must at least know what metals have affinity, and those that are antagonistic, and to what extent metals influence each other and will properly alloy. When it comes to the production of a high-grade anti-friction metal like Magnolia, it requires special fine points carried out with the precision of a druggist prescription by specially trained and skilled workmen, and the mere knowledge of the formula would in itself be of little use in imparting the special characteristics and value of that product.

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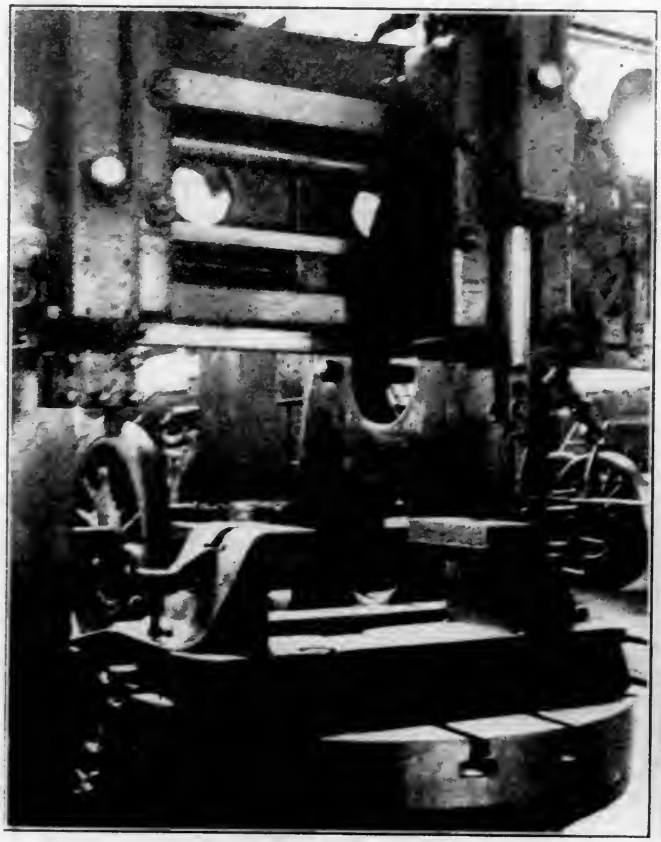

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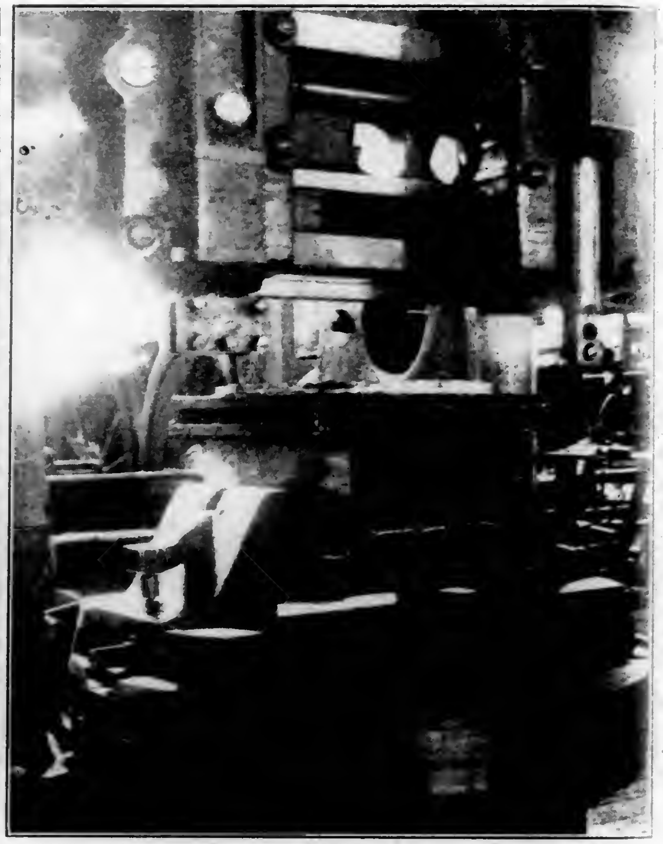

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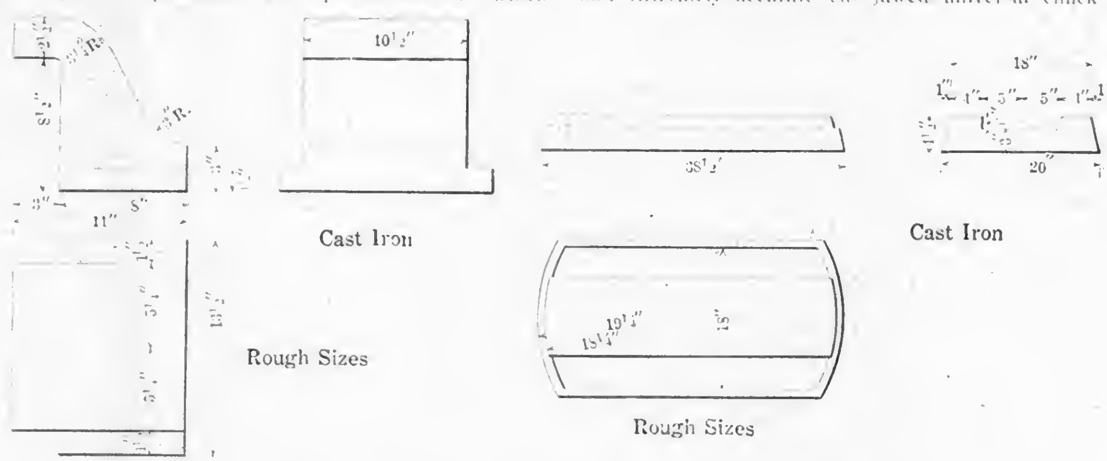

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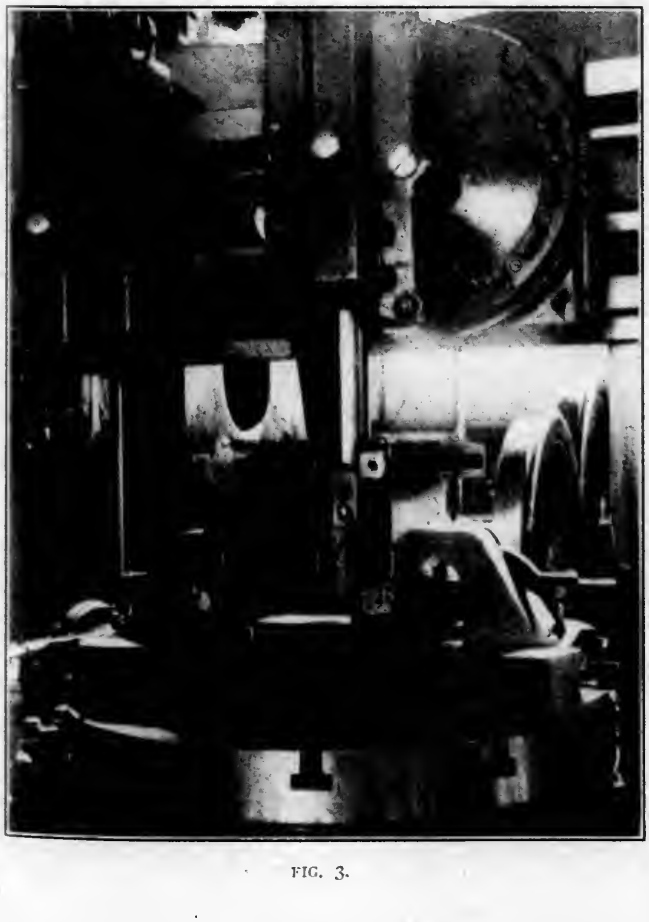

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CONTENTS

THE ACCURACY OF VALVE GEARS

It is a common remark of inventors, in describing the claims of new valve gears, to say that they are mathematically correct, or that they give an excellent, or nearly perfect distribution of steam, but it might be well to ascertain just what such claims and assertions really mean. Anyone who has studied valve gears by Zeuner's diagram and equation knows well that for all gears controlled by any form of circular motion from the engine driving axle the travel of the slide valve from its middle position is a function of the angle of the revolution of the crank, that is to say, the slide valve opens, suppresses, exhausts, compresses and opens again at equal angles on the crank path from either dead point, not at equal points in the piston stroke. From the Zeuner standpoint, therefore, only a crank path equality of angles can be termed mathematically correct. Very few valve gears have ever been invented which give an absolutely true polar-circle diagram, every stage of the valve movements being at equal angles on the crank pin from either dead point.

Designers of valve gear, however, do not desire this sort of regularity. Their aim is to produce equality of cut-offs in the cylinder, tempered with a slight excess on the instroke sufficient to recoup loss of piston rod area, or in vertical engines a slight excess on the lower side of the piston to partially balance its weight. Owing to the angularity of the connecting rod the piston always travels further on the outstroke than the instroke, unless it be specially adjusted to avoid this; in other words, to get equal work done on both sides of the piston every effort is made to prevent such gears from acting with "mathematical correctness." Designers of locomotive valve gear, while aiming at tempered equal cut-offs on the stroke, do certainly try to get the exhausts at equal angles on the crank path, but this is for a wholly different reason, namely, to get a regular beat for the exhaust, as it is found that an irregular exhaust does not produce so good a smoke box vacuum, and needlessly tears the fire about. As the crank on a locomotive revolves at a constant speed it is clear that to get regular beats exhausts at equal crank angles are necessary.

To get the cut-offs equalized and tempered on the two strokes all sorts of expedients are adopted for "doctoring" the gear, advantage being taken of local disturbances in the gear to set one off against the other, so as to produce the desired result. In link motion work the moral maxim that two wrongs never make a right does not hold good. With this object the position of the reversing shaft is shifted about, eccentric rods are made of unequal lengths, and unequal angles of advance are given to the eccentrics.

Without the dodging and doctoring referred to, all valve gears wholly operated by eccentrics or return cranks actuated by the driving axle tend, when laid down in their simplest and most theoretically dictated forms, to give valve movements equalized on the crank path. All single and double eccentric link motion gears come in this class. All radial valve gears where the port opening movement is obtained by a return crank or eccentric also tend to give valve moments equalized on the crank path and form one class with the above. Only those radial gears where the port opening movement is obtained from the to-and-fro motion of the crosshead, tend, so far as local disturbances of this gear may permit, to give valve movements equalized on the stroke of the piston.

There is a very common, not to say general assertion, made by all sorts of writers, that radial gears are superior to link motions in giving a later exhaust with less compression. Joy asserted this of his gear, claiming that he could work in marine engines with a single slide valve only, where before with a link gear a special expansion valve was necessary. Such a claim is not according to fact. No greater improvement in that respect is obtainable than by employing a link gear, properly proportioned and sufficiently doctored. Experiments with full-sized model boards have demonstrated that for all practical purposes radial gears and link gears, designed for the same engine, with same lap and lead, act identically, and the valves operated by both more synchronously.

THE PASSING OF THE OLD TIME ROUNDHOUSE

The fine locomotive terminal at New Durham, N. J., which is described and illustrated elsewhere in this issue, forcibly attests to the grateful fact that the day of the dilapidated old roundhouse, with its utter lack of facilities so characteristic of the nineties, is no more. Although practically the last of shop buildings to be accorded its true importance, the rehabilitation during the last few years has become general, and few of the larger roads remain without examples of up-to-date construction, or where plans have not been prepared to remove the antiquated structures.

It is a singular fact in connection with roundhouse design of twenty years ago that little or no attention seems to have been paid to the requirements of the future, although in the instance of the erecting and other departments provision was almost invariably made for expansion. Many of the roundhouses were out of date three years after they were built, and soon became hopelessly so with the advent of heavier power. The severity of northern winters renders it absolutely necessary that the doors shall be closed behind the locomotives, and this no doubt had much to do with giving the present reform its impetus. At all events, it is a move decidely in the right direction, and if persisted in the former appearance of these important buildings will live only as a memory.

BE FAIR TO THE MASTER MECHANIC

The unusually large number of "resignations" which have been so prominent in connection with the conduct of motive power department procedure of late afford additional testimony to the now generally accepted fact of the unstability of railroad positions in general, and of mechanical offices in particular. It would be interesting indeed to delve below the surface for the real causes which brought about many of these dismissals, which are so charitably cloaked under the guise of voluntary retirement. Such an inquiry would reveal some very peculiar conditions, and if persisted in an astonishing amount of injustice as well.

Circumstances attending the ordinary severance of service with a railroad are usually very much involved. In only about one-half of the cases is any cause assigned for the action, and the victim may remain for years in darkness, and maybe during the remainder of his existence, without enlightenment. This reference, not at all exaggerated, is in particular to the office of master mechanic, which appears to be that especially ordained to receive the buffets of adverse fate. Of course, there are instances quite frequent where a removal is fully justified through incompetency, or poor executive ability, and nobody wonders, but there are many mysterious decapitations, which defy the assignment of a reason.

Positions are nominally safe, if adequate service is returned, until the grade of general foreman has been passed, because foremen are shown their delinquencies, and if any exist have an opportunity to correct them. Unfortunately, however, and through some undefinable reason, no such liberality is extended to the master mechanic, whose ground is often slipping from under his feet although he knows it not.

Two instances are recalled at this writing, and a dozen more could be as readily brought to mind, where incumbents of that office were summarily dropped on very short notice, and with, of course, no reason assigned. Both of these men thought themselves absolutely secure in their positions. One of them during the three years of his administration had made a substantial reduction of some twenty thousand dollars in his payroll, and each had vastly improved the engine failure situation. They purchased homes and identified themselves with their respective towns. The service rendered by each had been consistently good from the start, and they were in all fairness entitled to an explanation of their removal.

Certainly these were instances where inefficiency was not the cause. It looks very much as though a factor were present in these two cases not in keeping with the dignity of railroad management, and that both men were the victims of personal spite. Such incidents are not conducive to the inspiration of confidence in their superiors which subordinates must possess to insure good railroading. Every man on that road holding a similar position knew that he was no better qualified than the two who had fallen, and the resultant feeling of insecurity and apprehension must leave its reflection on their work.

The master mechanic is deserving of more consideration than he usually receives. It is a troubled position at the very best and it represents many years of successive promotion through the subordinate grades. It does not seem a fitting reward for all this effort which must be put forth to place a man in middle life where he can only count on the tenure of his job from one monthly pay check to another. Certainly it is not asking too much that the master mechanic should be extended the same right to defend himself which is not denied to his most humble subordinate.

There was a case where a master mechanic had been uniformly successful over quite an extended period, at least three years, in charge of one of the largest locomotive terminals of the country. It was a union road, but his tact and fairness was such that he was fully endorsed by all divisions of its organized labor. It was never disputed that his administration was efficient and economical, yet he lost out on two days' notice through the following combination of circumstances: A certain engine from another division did not prove suitable in the fast train service for which it had been sent, and to which it was assigned from headquarters without definite knowledge of that service.

In consequence it was necessary, in order to preserve the former good record of this train, that the recently received locomotive be taken off, and a return made to the original engine which had always handled the run satisfactorily. This was done, only to be promptly excepted to by headquarters, followed by an order that the assignment of power be carried out as directed. The master mechanic explained fully by letter that the engine which had been sent him was unsuitable in many ways, particularly in faulty frame construction which did not allow the cylinders to remain tight for any length of time, resulting in leaky steam pipes and steam failures. The reasons advanced were practical and explicit, and on being returned to the run a series of failures occurred.

The headquarters, at least two divisions removed from the territory in question, thereupon sent a man familiar with the division to run the engine and report. Before doing so he had the steam pipe joints reground for the third time in ten days, and through virtue of this, which was really necessary from what has been said, a successful round trip was made. On the completion of this the man returned his report, in which it was said that the engine was in every way fitted to handle the train, and the impression was created thereby in the general offices that the master mechanic was simply "bucking" against the interference with the affairs of his division. The master mechanic was then dismissed from the service with the two days' notice previously mentioned, and on the third, or following day to his retirement, the engine was again in the roundhouse for leaky steam pipes.

This incident has been somewhat detailed as illustrative of the, at times, curious working of railroad justice. The master mechanic was a thorough mechanic who had proved his ability through a long period marked by the most exacting requirements. He knew his train service and his engines and if let alone would have no doubt continued with equal success. The man sent by the general offices to make the demonstration knew practically nothing about a locomotive, and was only an indifferent engineer, and yet his report, after riding but the one trip, was blindly accepted despite that the master mechanic was already on record in pointing out the inherent weakness of the engine in question. After his retirement from the service the frames were remodeled and various other changes made as indicated.

TABLE I.

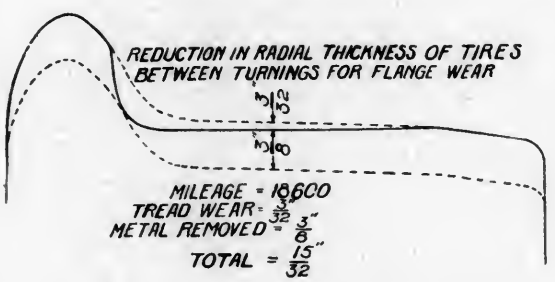
Railroads Reporting Flange Wear on Locomotive Driving Wheels.

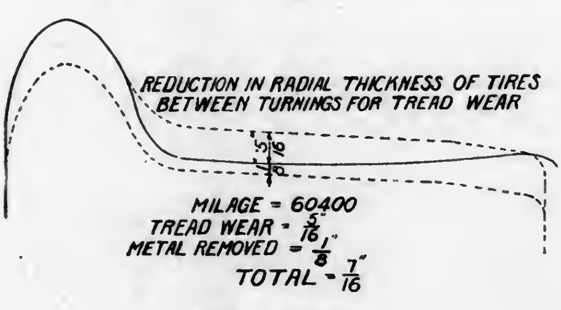
Railroad.	Curvature.	Grade.	Types most Effected	Mileage between Turnings. — For Flange Wear.	Mileage between Turnings. — Estimated Proper.
C. R. I. & P.	6°	1%	2-8-0	40,000	90,000.
C. P.—Lines West	10°	Max.—5% Much mileage, 2.2%	2-8-0	*	96,000 to 120,000.
E. P. & S. W.	7½°, 12°, 16°, 33°	1%, 3%, 5.7%		*	
S. P.—Sacramento Div.	8° and 10°.				
Santa Fe—Coast Lines.	10°	Max.—3% 25 miles—2.2%	2-10-2	†	
Santa Fe—N. Mex. Div.	6°, 8°, 10°, 14°	1.4% to 3.7%	4-6-2	2-10-2—18,000 to 20,000. 4-6-2—25,000 to 30,000	35,000 to 40,000. 75,000 to 100,000.
Santa Fe—So. West Lines	6°.	.5%	4-4-2	4-4-2—10,000 to 15,000 2-6-2—25,000	75,000. 50,000.
Santa Fe—Gulf Lines.	6°.	1% to 1¼%	4-6-2 2-8-0	60,000	75,000 to 80,000.
Santa Fe—East Lines	6°, 7°-30′	.8%	4-4-2 0-6-0	18,600	60,000 to 70,000.
C. & S.—Narrow Gauge	35°.	4%	2-6-0	40,000	
P. R. R.	10′ to 6°	.606%	4-4-2 2-8-0	Pass.—75,000 Fr't—35,000	75,000. 35,000.
P. R. R.—West Penn. Div.		1% to 1.85%	4-6-2 0-6-0		
Vandalia.	3°.	.9%	All types same	40,000	70,000 to 80,000.
B. & L.E.	4° to 22°	.17% to 1.1%	2-8-0	* 28,000	 28,000.
H. V.			All tpyes same	30,000 to 35,000	60,000.
D. & H.	2° to 14°	1.75%	2-8-0 Mallet	40,000	40,000.
L. S. & M. S.—Yard Engines.	10°, 12°, 17°, 20°	Light	0-6-0 0-10-0	50,000 to 20,000 Average—15,000	32,000 to 60,000.
W. P. T.	5°, 11°, 28′	1% to 1.45%	Mallet	*	
I. C.	Main Line—6° Yard—32° to 50°	1¼%	0-6-0	Pass.—90,000 Freight—60,000 Switch—25,000	120,000. 80,000. 250,,000
A. B. & A.	6°	1%	4-6-0 0-6-0	14,000 to 15,000	40,000 to 45,000.
T. R. R. Ass'n of St. Louis			Switch	4,000 to 55,000	50,000.

*Tread wear mileage is obtained between shopping by shifting tires from one pair of wheels to another, thus providing new flanges at the point of severest wear.

†Tread wear mileage has been obtained between shoppings since the application of lubricators.

Two railroads report very little flange wear.
Five railroads report flange lubricators in use; no other data.
Eight railroads report no flange lubricators in use; no other data.





FIGS. 1 AND 2.

TABLE III.

Loss of Tire Mileage Due to Excessive Flange Wear.

4-4-2 Type, operating on Missouri Division, A. T. & S. F. Ry.:

Mileage between turnings—Flange Wear (7/8" to 1" vertical)		18,600
Mileage between turnings—Tread Wear (5/16" maximum)		60,400
Flange Worn	Metal removed to build up standard flange	3/8"
	Tread Wear (Rate 5/16" per 60,400 mi.)	3/32"
	Total reduction in radial thickness between turnings	15/32"
Tread Worn	Metal removed (To facilitate turning)	1/8"
	Tread Wear	5/16"
	Total reduction in radial thickness between turnings	7/16"

Flange Worn Tires. — Thickness of Tire.	Flange Worn Tires. — Average Mileage.	Tread Worn Tires. — Thickness of Tire.	Tread Worn Tires. — Average Mileage.
New, 3½"		New, 3½"	
After first turning, 3½"	18,600	After first turning, 3 1/16"	60,400
After second turning, 2 9/16"	18,600	After second turning, 2 5/8"	60,400
After third turning, 2 3/32"	18,600	After third turning, 2 3/16"	60,400
Scrap	18,600	Scrap	60,400
Estimated total	74,400	Estimated total	241,600

Total loss of mileage during life of tires 167,200
Loss, per cent, "-69-"

Master Mechanics' Association

Forty-fourth Annual Convention.

(Concluded from page 280, July issue.) *

FLANGE LUBRICATION

Committee:—M. H. Haig, Chairman; T. W. Heintzelman, D. J. Redding.

It has been the purpose of the committee appointed to report on flange lubrication to obtain sufficient information to determine, (1) to what extent trouble from flange wear is experienced, (2) the lubricants and means of applying them which are in use and (3) the effectiveness of lubrication in overcoming flange wear and its attendant evils. A circular of inquiry was issued and the committee's report is based upon the replies received from motive-power officials of about thirty railroads representing widely different grade, curvature and weather conditions of operation. The committee, therefore, feels justified in looking upon a synopsis of these replies as indicative of the flange-wear situation and, in general, the effectiveness of lubrication.

Among the detailed replies to the committee's circular, two only indicate that the officials represented are not having trouble in their territory from flange wear. In addition, five replies state that lubricators are being used or experimented with, which indicates trouble from this source. Eight answers, on the other hand, state that the railroads represented have no lubricators in use, and, unfortunately, no statements are made as to flange-wear conditions. Among these are the Erie, in the East, and the Great Northern, in the West, both of which pass through a mountainous territory, and, therefore, have a large number of curves to contend with. The Erie, however, is investigating with a view to adopting flange lubrication, a fact which would indicate that it is experiencing some trouble due to flange wear.

The Lake Shore & Michigan Southern Ry. reports having no trouble with road engines, but in some yards the wear on driving-wheel flanges of six and ten-wheel switch engines becomes a very serious matter. The Santa Fe has had the same experience with six-wheel switch engines where a large percentage of the total mileage is made on curved track.

The railroads reporting flange wear are shown in Table I, together with maximum curvature and grade conditions and the locomotive types most effected. This table presents a review of the flange-wear situation as complete as the data at hand will permit.

It will be noticed that with one exception the curvature reaches a maximum of six degrees or more. It would seem, however, that the mileage of curved track relative to total mileage would produce more effect on flanges than the degree of curvature alone. There are a number of other conditions affecting flange wear: among them are length of rigid wheel base, speed, lateral movement and tire spacing, and the degree of stiffness of engine truck.

Pacific in passenger service and consolidation in freight service are the types on which flange wear is most prevalent. However, where types are employed with longer wheel base than the consolidation, these are reported as being subject to greatest flange wear. In general, if other conditions are equal, it is the type with longest rigid wheel base on which flange wear is greatest.

There are some notable exceptions to this rule in passenger service. One division of the Pennsylvania Railroad with engines of the Pacific type in service reports greatest flange wear on those of the Atlantic type. This is also the case on the Eastern Lines of the Santa Fe System. While there is no statement to this effect, this condition may be due to the Atlantic type operating on a section of the road more severe on flanges because of excessive curvature.

There are two classes of expense due to excessive flange wear. One results from the metal lost in producing standard flanges after they have been badly worn and the other is due to the loss of revenue and the cost of repairs when necessary to turn or remove tires from flange wear between regular shoppings of the engine.

The figures covering metal loss have been presented according to different standards and it is, therefore, difficult to compare them. In some instances, the loss has been measured in radial thickness of the tires, in others by weight per turning, and in still other cases by the value of metal turned off. Where stated in radial thickness, the amount varies between ¼ inch and ¾ inch. Loss in weight is stated as carying between 55 pounds and 1,150 pounds per engine per turning, depending upon the number of wheels and the extent of flange wear. The loss of metal expressed in terms of money value for engines of various types is given as follows: Four-wheel switch, \$45; six-wheel switch, \$50; standard, \$50; ten-wheel, \$50; consolidation, \$60; Mallet, \$90.

The total mileage obtained during the life of a set of tires appears to be the most satisfactory measure of tire service. On this measure as a basis, the estimate presented in Table III has been prepared to show the loss due to turning tires on account of flange wear compared with the total mileage during the life of tires when turned for tread wear. It represents the service obtained from Atlantic type locomotives operating on the Missouri Division of the Santa Fe. The mileage between tire turnings is computed from the aveage mileage per locomotive per month and the time between turnings; the average mileage per locomotive per month was obtained from records of twenty locomotives over a period of eight months. Before lubricators were applied, these locomotives averaged 18,600 miles between tire turnings before reaching the limit of 1-inch vertical flange wear. Since the adoption of flange lubrication, the same locomotives average 60,400 miles between tire turnings for tread wear. Figs. 1 and 2 graphically illustrate the method of arriving at the aggregate loss given in Table III. In Fig. 2 is shown the condition of tires with 5/16-inch tread wear after making 60,400 miles. To facilitate proper turning, ⅛ inch is usually removed in the lathe. The total reduction in radial thickness between successive tire turnings will, therefore, amount to 7/16 inch. Fig. 1 illustrates the condition of tires when the locomotive is shopped because of sharp flanges after making only 18,600 miles.

That this estimate may be conservative, a very liberal curve has been assumed at the throat of the worn flange. In order to reproduce the standard tire contour it is necessary to turn off ⅜ inch of metal from the tread. The total reduction in radial thickness between tire turnings is 15/32 inch, which is 1/32 inch greater than the total shown in Fig. 2. Assuming a minimum thickness at the last turning of 2 inches, the difference in total mileage during the life of tires under the two sets of conditions is 167,200, a loss in tire service of 69 per cent. due to flange wear.

The loss of revenue and the expense of turning and changing tires when locomotives are taken out of service because of worn flanges is shown by Table IV. The experience of several different railroads is given and the data presented are as complete as it has been possible to obtain. In some instances, where flange wear is excessive, when the front pair of tires becomes badly flange worn, it is removed and exchanged with another pair from the same locomotive. On locomotives with four pairs of drivers, two shifts may be made. But under severe conditions, it is impossible by this means alone to keep locomotives in service until the tires become tread worn. In Table VI-A, showing the estimated saving due to the use of flange lubricators on the Southern Pacific, the average mileage per change of tires necessitated by flange wear is given as 8,869. The practice was to make two shifts of tires before turning. Computed on this basis, the mileage between successive turnings for flange wear is only 26,607, while tread-wear mileage obtained since the application of lubricators is 42,151.

Since the increasing prevalence of flange wear has been forcing it to the attention of motive power officials, many methods of lubrication have been applied in the effort to overcome this evil. Fourteen different forms of lubricators are now in use or have been tried by the railroads reporting to the committee. These may be grouped according to the kind of lubricant used into the following classes: (1) crude oil; (2) engine and car oil; (3) solid lubricant, (4) water; (5) exhaust steam.

There are four types of lubricators designed to use asphaltum base crude oil. These are the Chicago, the Southern Pacific, the Canadian Pacific and the Rock Island. Where no other name is known that of the railroad upon which the lubricator has been developed is used.

The Chicago Flange Oiler is designed to meet the requirements of the Elliott system of lubrication, which embodies a sight-feed oiler located on the back boiler head and a delivery pipe on each

* The July issue contained report as follows: Lubrication of Locomotive Cylinders, Safety Appliances, Mechanical Stokers, Contour of Tires, Repair Equipment for Engine Houses, Main and Side Rods, Locomotive Performance Under Superheat, Opening and President's Address, Advisory Technical, Election of Officers, Design, Construction, Inspection of Boilers, Minimum Requirements of Headlights, Consolidation, Revision of Standards, Safety Valves.

TABLE IV.

LOSS OF REVENUE AND COST OF LABOR DUE TO FLANGE WEAR.

Railroad.	Time Out of Service when Shopped for Sharp Flanges.	Loss of Revenue.		Labor Charges.			
		Per Day.	Per Shopping.	To Change Tires.		To Turn Tires.	
C. R. I. & P.	2 days	$20.00	$40 00	4-6-2 2-8-0	$15.00 20.00	4-6-2 2-8-0	$ 7.00. 8.00.
C. P.—Lines West				*	8.00	2-8-0	3.00.
E. P. & S. W.						2-8-0 4-6-2	4.20. 3.15.
S. P.—Salt Lake Div.	**			2-8-0	15.00	2-8-0	4.00.
Santa Fe	5 to 30 hours††	$25.00	$5 to $35	4-4-2 2-10-2	3.00 7.00	4-4-2 2-10-2	3.35 8.28
P. R. R.	18 to 20 hours	$39.00	About $30.00	4-6-2 4-8-0	30.92 20.86	4-6-2 2-8-0	33.77. 21.64.
P. R. R.—W. Penn. Div.	24 hours up	$2.50 per hour.	$60.00 up	2-6-2 2-8-0	28.05 26.66		
Vandalia	2 or 3 days			4-6-2 2-8-0	6.30-19.80 8.40†	4-6-2 2-8-0	6.40. 6.72.
B. & L. E.	To turn-60 h'rs. To change—12 hours	$25.00	$62.00 $12.00	4-6-0 2-8-0	13.32 18.00 to 20.00	4-6-0 2-8-0	4.10. 5.20.
H. V.	6 days		$66.00				
D. & H.	24 hours	Varies.		4-6-2 2-8-0		4-6-2 2-8-0	$2.10 to $2.70 2.80 to 3.60
L. S. & M. S.	Shop—10 hours R. House—2 d's	Capital charges only.		-006-	6.00	0-6-0	$12.00.
W. P. T.	10 days	$11.00	$110.00	Mallet.	90.00	Mallet.	90.00.
I. C.	24 hours	$10.00 to 15.00	$10.00 to 15.00	0-6-0 2-8-0 4-6-2	15.50 24.00 30.00	2-8-0 4-6-2	2.92. 2.88.
A. B. & A.	5 or 6 days	‡$82.00	$4.40 to 4.92	4-6-0 0-6-0	11.40 13.68		10.00.
T. R. R. Ass'n of St. Louis	2 or 3 days			0-6-0	13.80	0-6-0	4.80.

*Two pairs of tires exchanged.
†$19.80 for 4-6-2 type with retaining rings.
‡Based on gross earning capacity.
**No engines shopped because of sharp flanges.

†† Depending upon number of wheels, and whether tires are replaced by others, or same tires are turned and replaced.

side of the engine leading to the flange nozzles. The oiler is similar in general appearance and principle of operation to the sight-feed valve-chamber lubricators in general use in America. The manufacturers recommend that the nozzles be located 15 inches above the rail, 2 inches from the flange toward the outside of the tire and close in toward the tread. Where two pairs of nozzles are used, each delivery pipe is branched through a "T" pipe connection. Where more than two pairs are used either two-feed oilers or one four-feed oiler should be provided. The manufacturer's practice is to apply one pair of nozzles in front of forward driving wheels on road engines; one pair in front of forward drivers and one pair back of rear drivers on switch engines; on Mallet engines in road service, one pair in front of forward drivers on both engines, and in pusher service one pair in front of forward drivers of both engines and a third pair back of rear drivers on high-pressure engine.

The Wabash Pittsburg Terminal Ry. applies nozzles to all drivers on standard type; to front and main drivers on ten-wheel type; to front and back drivers on consolidation type; to main and back drivers on six-wheel switch engines; and to front and back drivers of both engines on the Mallet type. A few consolidation engine trucks are also equipped.

The Lake Shore & Michigan Southern Ry. applies lubricator nozzles to all drivers on switch engines. The practice adopted by the Santa Fe System is to apply nozzles to the rear of forward drivers where trouble is experienced from frozen sand pipes with nozzles placed in front of the drivers.

The lubricator developed by the Southern Pacific Company after experiments covering the use of a number of other methods of delivering oil to the flanges consists of a steam-jacketed receptacle holding about one and one-half pints of crude oil, which is fed by gravity through a needle valve into the one-half-inch delivery pipe. A clamp bracket gripping the pipe just below the oil cup secures the oiler to the engine frame in front of the forward drivers. Loosely sliding upon the delivery pipe is a piece of one-inch pipe over the lower end of which is slipped a short section of one-inch rubber hose. The projecting end of the hose is shaped to fit the throat of the flange and acts as a shoe to distribute the oil. A weight rigidly attached to the upper end of the one-inch pipe holds the shoe against the flange at all times. The oil-cup jacket is supplied with steam from the air-pump exhaust pipe, which serves to keep the oil in a fluid state during cold weather. The drip from the jacket runs along the delivery tube, tending to prevent congealing of the oil before reaching the flange.

The Canadian Pacific Railway, having tried hard grease and engine oil without success, is about to try crude oil in a lubricator similar to the Southern Pacific type in principle. Oil is fed through a regulating valve from the cup to the feed pipe and flange shoe, which consists of a piece of rubber hose. Steam from the air-pump exhaust pipe passing through a coil placed within the oil cup maintains the oil in a fluid state.

The Chicago, Rock Island & Pacific Ry. is using a lubricator on two Pacific type locomotives in which the oil receptacle stands upon the running board over the right cylinder. Exhaust steam passes through a pipe leading from the exhaust cavity in the cylinder casting to the oil cup. The accumulation of condensation in the oil cup lifts the lubricant into the delivery pipe, exhaust steam carrying it to the flange. The flow of oil is controlled by the engineer through a globe valve operated by a rod extending back to the cab. A check valve placed in the pipe leading from the cylinder exhaust cavity prevents a back flow of oil through this pipe.

There are two lubricators in use employing lubricant in solid form: the Collins and the Turnbull. The Collins has a bracket attached to the frame supporting the lubricator in position before the driver.* The angle of the lubricator is adjustable to suit conditions imposed by the location of the bracket, on which it is laterally adjustable. The angle should be as nearly as possible twenty-five degrees from a line parallel to the axle and it should be paced on the horizontal center line of the wheel.

The Turnbull lubricator embodies the same principle as the Collins, spring pressure holding a cake of hard grease against the flange. The committee is informed by the manufacturer that this device is no longer marketed.

Great economy in the use of lubricant is claimed for hard-grease lubricators. When the flange has become once coated there is no further deposit of lubricant until this coating is removed by contact with the rail.

The feed is automatically regulated to suit the varying needs of the flanges. On the Colorado & Southern Ry., however, it has been found that the grease used in the Turnbull lubricator absolutely loses its merit in either wet or cold weather and its use has been abandoned. On the Canadian Pacific, Lines West, hard-grease lubrication has been found unsatisfactory. The committee is unable to state what type of lubricator was used.

Several methods of delivering engine and car oil to the flange have been tried. The simplest is a piece of pipe or hose secured to the frame in front of the driver in such a manner as to cause the lower end to bear against the flange. The pipe or hose is

* See AMERICAN ENGINEER, Oct. 1910, p. 415.

filled with oil-saturated waste, which acts as a swab, more oil being supplied from time to time. This type is sometimes varied by providing a graduated feed-oil cup to supply oil to the swab. Although this simple device has proved beneficial, it has usually been abandoned for some more efficient method of lubrication. Where the waste comes in contact with the tire, if packed hard, it will glaze and cease to be effective. If loosely packed it will be drawn out and lost.

Crude oil is being used in this manner on the Illinois Central Ry. A piece of 2-inch tube is flattened at one end and shaped to the contour of the flange. It is clamped to a hinge bracket so that the weight of the pipe itself tends to keep it in contact with the flange. The tube is packed with waste saturated with fuel oil. The shape of the opening at the flange is such

TABLE VIa.

ESTIMATED SAVING BY USE OF DRIVER FLANGE LUBRICATORS ON FORWARD DRIVERS OF MOUNTAIN ENGINES, SOUTHERN PACIFIC.

1.	Total mileage of ten selected engines before application of flange lubricators; from January 1, 1906 to date of application	629,703
2.	Total cost of tire attention, from January 1, 1906 to date of application of flange lubricators....	$6,108.00
3.	Cost of tire attention per mile run, before application of flange lubricators....	$.0097
4.	Number of times tires were changed from January 1, 1906 to date of application of lubricators, including tire turning	71
5.	Average mileage per change of tire, before application of lubricators....	8,869
6.	Total actual mileage of ten selected engines since application of flange lubricators....	421,513
7.	Average mileage per change of tire since application of flange lubricators....	42,151
8.	Cost of tire attention per mile run after application of flange lubricators....	$.002041
9.	Percent of increase in mileage per change of tire....	375
10.	Percent of decrease in cost of tire attention per mile run....	79

69 CONSOLIDATION ENGINES.	Average Mileage per engine per month.	Total Mileage per Year.	Cost per Mile Run.	Total Cost of tire attention One Year's Service.
Before application.....	2491	2,062,548	$.0097	$20,006.72
After application......	2635	2,181,780	.002041	4,453.01
Estimated saving effected on mileage obtained with flange lubricators based on cost per mile before use of same..............	....	2,181,780	$.007659	$16,710.25

that the waste will not be in contact with the tire. This device is being used to a limited extent on Pacific type engines with very little apparent benefit. It is not reliable in cold weather.

The Canadian Pacific has experimented with a syphon lubricator using engine oil, but this has proved inefficient and has been abandoned for the fuel-oil lubricator.

Another simple device has been applied to six-wheel switch engines in the Chicago yard of the Santa Fe. It is simply a block of wood resting upon the tire and grooved to fit the flange. A waste-filled cavity contains engine oil which feeds through a ⅛-inch hole to the flange. The block is loosely anchored, and is usually applied to forward and back drivers.

The Chicago, Rock Island & Pacific Ry. has ten Pacific and three consolidation locomotives arranged with piping to carry water from the tank nozzles spraying against the leading drivers. This means of lubrication is of very limited service. The pipes run horizontally along the engine frames and cause trouble by freezing during winter weather.

The Pennsylvania Railroad has made use of exhaust steam from the air pump, with what success we are not informed.

Of the lubricators described, all are in very limited use except those using crude oil.

Flange lubrication on the Santa Fe has been developed to its present state after experiments covering the use of most of the simple devices, such as swabs of oil-saturated waste, water-jets operated from the injectors and the block type. These have all proved to be in some manner unsatisfactory. In using the simple swab difficulty was found to keep it against the flange and the waste was frequently lost. When forced against the wheel with sufficient pressure to insure constant contact the pipe was rapidly worn away, sufficient heat often being generated to ignite the waste. The water jet caused clogging of the sand pipes. Water and engine oil have both proved too light to satisfactorily resist the action of centrifugal force, being thrown away from the throat of the flange before reaching the rail. It has been found that the wood block lubricator spreads oil over the tire tread and, consequently, tends to cause slipping of the drivers.

Crude oil is now in general use for flange lubrication on the Santa Fe System. Oil from the Kansas field has not been found heavy enough to properly adhere to the flange, but that from Bakersfield, California, which is now used, has proved very satisfactory.

Experience indicates that the delivery of a proper lubricant to the flange will reduce the wear of both flange and rail. The committee's information is confined largely to the results obtained by lubrication with crude oil. California crude oil contains a high percentage of petroleum asphalt. When delivered to the rail by the driving-wheel flange, it forms a thin coating of paste on the inside of the ball of the rail which does not run or spread over the top. When all engines on a division are equipped with lubricators the rails on the outside of curves will become thus coated and friction will be reduced on all wheels passing over the track. The resulting reduction in flange wear is noticeable on both passenger and freight car wheels, but data is available for locomotive driving wheels and tender truck wheels only. It necessarily follows that train resistance is much reduced on curves.

Reference has already been made to the losses due to flange wear in Tables III and IV. The record of Atlantic type locomotives referred to in Table III is a good illustration of the service of flange lubrication. These locomotives operating on the Atchison, Topeka & Santa Fe Railway averaged four months with a mileage of 18,600 between tire turning due to worn flanges. The division to which they were assigned includes a large amount of curved track and to increase the mileage between tire-turning flange lubricators were applied. Since their adoption, tires on the same locomotives remain in service about thirteen months, when it becomes necessary to turn them because of tread wear. During this period, the engines will average a total service of 60,400 miles. It must be added, however, that at about the time lubricators were applied, a grade revision commenced and the curvature has since been reduced on the division over which these engines were operated. But this was not completed soon enough to have any marked effect in the saving which was immediately apparent after applying lubricators.

The block lubricator previously described applied to six-wheel switch engines has extended the period between turning for flange wear in some cases from two months to one year.

On the New Mexico Division, a 65-mile section of which has 288 curves of 6, 8 and 10 degrees, it was found impossible to keep engines of the Santa Fe type in service for more than 18,000 to 20,000 miles. After one of these locomotives had made this mileage flanges were so badly worn that it was necessary to remove all wheels and turn the tires or shift them from one pair of wheels to another. At the present time, with lubricators applied they are making as high as 35,000 to 40,000 miles between shoppings with no evidence of flange cutting. On Pacific type locomotives operating through the same territory the difference is even greater. The mileage formerly obtained was about 25,000 to 30,000, which has been increased to 75,000 to 100,000 miles, with flanges still in good condition. The performance of lubricators has been closely watched in this territory. There are instances where lubrication has not entirely stopped flange wear because of the difficulty experienced in getting engineers to give the lubricators proper attention.

There are no data on the Santa Fe to show the exact increase

TABLE VI.

TENDER TRUCK WHEELS.

SAVING EFFECTED BY USE OF DRIVER FLANGE LUBRICATORS ON FORWARD DRIVERS OF MOUNTAIN ENGINES, SOUTHERN PACIFIC.

Total mileage of ten selected engines before application of flange lubricators, from January 1, 1909, to date of application	629,703
Number of pairs of tender truck wheels changed from January 1, 1909, to date of application of flange lubricators	148
Mileage per change of tender truck wheels....	3,517
Estimated cost to change one pair of tender truck wheels....	$15.55
Cost of tender truck wheel tire attention per mile run....	.00442
Number of pairs of tender truck wheels changed from date of application of flange lubricators to December 31, 1908....	9
Total mileage of engines from date of application of flange lubricators to December 31, 1908....	169,529
Miles run per change of tender truck wheels....	18,837
Percent of increase in mileage per change of tender truck wheels....	435.59
Cost of tender truck wheel tire attention per mile run....	.00082
Percent of decrease in cost of tire attention....	81.45

69 CONSOLIDATED ENGINES.	Average Mileage per month per engine.	Estimated Total mileage per year.	Cost per Mile Run.	Estimated Total cost of tire attention one year service.
Before application.....	2,491	2,062,548	$.0042	$9,116.46
After application......	2,559	2,118,852	.00082	1,737.46
Amount saved by use of lubricators....	....	56,304	....	$7,379.00

in the life of rails on curves effected by the flange oilers. On the New Mexico Division, with 100% of the locomotives equipped, it has been estimated that there has been an increase of about two months in the life of rails, that previously required changing about every thirteen months. This is an increased life of 15 per cent. In territories where no figures are available, it is, however, the opinion of all officials that the flange oilers have materially decreased rail wear.

TABLE VII.

Record of Wear of Flanges in Connection with Test of Chicago Flange Oilers.

N. & W. Ry.

Equipped with Flange Oilers—Engines.

Engine.	In Service. From	In Service. To	Mileage.	Wear of Flanges. Max.	Wear of Flanges. Min.	Wear of Flanges. Avge.	Average Wear per 10,000 Miles.
1004	6-29-09.	11-11-10	49,256...	R-1 .36"	L-1 .04"	.170"..	.034"
1005	7-17-09.	8-29-10.	43,634...	L-1 .27"	R-1 .07"	.156"..	.036"
1006	8-6-09..	8-22-10.	38,938...	L-1 .22"	R-1 .02"	.126"..	.032"
Average of engines....................						.155"	.034"

Not Equipped with Flange Oilers—Engines.

Engine.	From	To	Mileage.	Max.	Min.	Avge.	Average Wear per 10,000 Miles.
100 0	8-4-09..	8-12-10.	36,728...	R-4 .30"	L-3 .00"	.148"..	.040"
1007	7-23-09.	8-11-10.	40,251...	R-1 .27"	L-3 .03"	.143"..	.035"
1009	9-15-09.	8-18-10.	35,628...	L-4 .11"	R-3 .02"	.066"..	.018"
Average of Engines..................						.151"	.031"

Tank Steel Wheels behind Engines with Oilers.

Engine.	From	To	Mileage.	Max.	Min.	Avge.	Average Wear per 10,000 Miles.
1004	....	....	....	R-1 .51"	L-2 .02"	.2207".	.042"
1005	....	....	....	L-3 .42"	R-3 .03"	.17"...	.039"
Average of both.....................						.196"	.041"

Tank Steel Wheels behind Engines Without Oilers.

Engine.	From	To	Mileage.	Max.	Min.	Avge.	Average Wear per 10,000 Miles.
1000	....	....	....	R-3 .31"	R-4 .00"	.10"...	.054"
1009	....	....	....	L-3 .17"	R-4 .00"	.20"...	.028"
Average of both						150"	.011"

Oil.

Engine.	Used Gal.	Price, Gal.	Cost per 10,000 Miles.
1004............	42	$0.25	$2.15
1005............	40	.25	2.29
1006............	48	.25	3.08

The Southern Pacific has gathered data showing the saving in tire attention effected on consolidation locomotives in mountain service. The average mileage per change of tires has been increased from 8,869 to 42,151, the cost of tire attention being thereby decreased 79 per cent. The miles per change of tender-truck wheels has been decreased in still greater proportion. From 3,517 before the adoption of lubrication it has been extended to 18,837, with a decrease in cost of tire attention of 81.45 per cent.

The effect on wear of rails has been no less marked. Where rails on 8-degree and 10-degree curves would last only about eight or ten months, conservative figures place the life since general application of flange oilers at about three years.

It is a fact that any device not directly necessary to the operation of the locomotive must perform its function with very noticeable results before winning the approval of the engineer. Flange lubricators on the Southern Pacific have become a necessary part of the locomotive equipment in mountain territory. When not working properly engineers complain seriously until they are repaired. Locomotives ride easier and smoother around curves, without the tendency to climb the rail which is evident when flanges run without lubrication.

On the Wabash Pittsburg Terminal Ry. before the application of lubricators the average time between shopping for sharp flanges was eight months. A ten-wheel freight engine, working on a section having maximum curvature of 11 degrees 28 minutes, would not run three months before developing flange wear to such an extent that tires had to be turned. Since applying the lubricator this engine working on the same section of the road was out twenty months before shopping, when tires were turned for tread wear. Since the application to all locomotives there has been no occasion to turn tires for flange wear. It has stopped almost entirely on wheels to which the oil is delivered, and oiling the drivers materially decreases the wear on engine-truck wheel flanges. In some cases, oil has been applied to the trucks where wear was unusually excessive. Mallet locomotives showed some signs of cutting the front flanges on the low-pressure engine. By plugging the nozzles leading to the back drivers on this engine and delivering the same amount of oil that was previously used on both pairs to the front wheels, the cutting has been reduced and it has been found that the other wheels are sufficiently oiled. In addition to the direct benefit to the locomotive, there has been a decrease in the wear of switch points and rails on curves, as well as a decrease in the number of derailments. Flange wear has also been reduced on tender truck wheels.

The Atlanta, Birmingham & Atlantic Ry. has obtained as high as 50,000 miles out of locomotives that ran only 13,000 to 15,000 miles before lubrication was adopted. A ten-wheel locomotive, weighing 130,000 pounds on drivers, in making 18,598 miles, had cut the front flanges very badly. Owing to the rush of work it was necessary to keep the engine in service if possible. A lubricator was applied and the engine again placed in service. After making 34,495 additional miles, the flanges showed no further wear. The tires were shifted and the engine again put into service. The Elliott system is in use on this railroad. The cost of oil has been about 3 cents per 100 engine miles.

The Norfolk & Western equipped four consolidation locomotives with lubricators and compared them in service with three others of the same type. The data obtained are presented in Table VII, which shows for each engine the wheel having maximum wear, the wheel having minimum wear and the average for all wheels, which is reduced to wear per 10,000 miles for the purpose of comparison. The average wear per 10,000 miles averaged for the three locomotives without lubricators is slightly less than the same quantity shown for three engines with lubricators.

A service test of a yard engine was made on the Kansas City Terminal Ry. The yard where this engine worked is so located that the front and back flanges on the left side of the engine became worn to such an extent that the engine began to climb the rail after being in service about three months. It was then necessary to change tires. The engine, equipped with a flange oiler, was put in service with a new set of tires and remained in service under these conditions over a period of thirteen months, when it was shopped for other repairs. The flanges were still in good condition. The results obtained were made possible by the careful attention the lubricator is reported to have received from the engineer.

The foregoing instances indicate the service of flange lubrication under some of the worst conditions affecting flange wear reported to the committee. Further data are presented in Table VIII. Opposite the initials of the railroad reporting is indicated the benefit derived from flange lubrication.

Discussion.—In view of the very excellent paper presented by Mr. Haig it would appear that this timely subject should have been accorded a more general discussion. T. O. Sechrist (C. N. O. & T. P.) said that before flange lubricators had been introduced on his road the average mileage before tires had to be changed was 12,000, but it is now possible to attain as high as 80,000 miles. The Chicago lubricator is in use there, with asphaltum crude oil as a base, in connection with the lubricator.

F. F. Gaines, (Cent. of Ga.) mentioned that he is getting very good results from the Ohio lubricator, also using crude asphaltum as a base, and is of the opinion that this device is the best for the purpose. This view was also shared by G. A. Hancock (St. L. & S. F.). In closing his paper, Mr. Haig, replying to a question of E. W. Pratt (C. & N. W.) in regard to the application of flange lubricators to trailing wheels, said that none such had been applied direct as yet on the Santa Fe, but there is every indication that the flange lubricator lengthens the life of the trailer wheels by spreading oil on the ball of the rail. The effect has also been observed under the tender, and to some extent on the wheels of the cars. The effect of slipping is not serious.

SMOKE PREVENTING DEVICES FOR FIRING UP LOCOMOTIVES AT TERMINALS

Committee:—E. W. Pratt, Chairman; J. C. Mengel, R. W. Bell, J. B. Kilpatrick, E. F. Jones.

The various reports and the experience of the individual members of the committee would lead to the following recommendations:

TABLE VIII.

Effect of Flange Lubrication.

Railroad.	Flange Wear Stopped.	Tires Run till Tread Wears.	Miles or Time in Service. Before Lubrication.	Miles or Time in Service. After Lubrication.	No. Engines Equipped.
C. R. I. & P.	Much reduced	Yes	One 2-6-0 Pass. Engine. 3 or 4 months	12 months	24
B. & L. E.	Much reduced	Yes	14260	23514	2
S. P.—Sacramento Div	Yes	Yes	See Table V.		....
S. P.—Salt Lake Div	Much reduced	*			49
A. B. & A.	Yes	Yes	Road—13,000 to15,000 Switch—3 to 4 months.	50,000 14 months	25
C. & S.—Narrow Gauge	Yes	Yes	6 months	General repairs, 12 months	4
W. P. T.	Yes	Yes	3 months	General repairs, 20 months	24
L. S. & M. S.—Yard Engines	Yes	Yes	Some Instances. 6 weeks	6 months	15
H. V.	Yes	Yes	0-6-0 type. 8,000	34,000	2
D. & H.	Yes	Yes	† 4 months	8 months	20
Santa Fe—Coast Lines	Yes	Yes	½ Tread wear life	Full life	240
Santa Fe—N. Mex. Div	Yes	Yes	Pass.—25,000 to 30,000 Fr't—18,000 to 20,000.	75,000 to 100,000 35,000 to 40,000	
Santa Fe—East. Lines	Yes	Yes	4-4-2 type. 18,600	60,400	120
Santa Fe—Gulf Lines	Reduced	No	60,000	75,000 to 80,000	30
Santa Fe—So. West. Lines	Reduced	Not always	10,000 to 25,000	50,000 to 75,000 Same cases 100,000	....
T. R. R. Ass'n of St. Louis	Reduced	No	About 6 months	About 8 months	2
M. Ry. of St. Louis	Reduced	Application too recent to determine.			4
E. P. & S. W.	Reduced	Application too recent to determine.			40
P. R. R.—West Penn. Div	No	No			13
N. & W.	No	See Table VI. and Figure 19.			4
I. C.	No	Experience limited.			Few
C. P.	Hard Grease and Engine Oil		Unsuccessful.		Few.

*Tires were turned for tread wear before lubricators were applied.
†Data apply to engines in pusher service. Increased life partly due to distribution of wear produced by turning the engines.

BOILER CONDITIONS BEFORE FIRING UP.

First.—The best results are obtained by filling up locomtive boilers with hot water previous to firing up; the temperature reported varying from 110° F. to over 200° F., the higher being preferred on account of aiding combustion and lessening the time required to raise steam in the boiler.

Second.—Where hot water is not available, the temperature of water in the boiler may be raised by injecting live steam below the water line; but on account of the loss of time, the heating of the water, either before or while the boiler is being filled, is recommended.

INDUCED DRAFT.

Third.—Two roads reported the use of large fans, connected with the smoke jack above the roundhouse roof, as a means for producing draft. One of these roads advises that this device was used and tested for a considerable length of time, but was found unsatisfactory and abandoned. The other road is still experimenting along this plan in connection with a "smoke-washer," and is not yet ready to report upon its results except as to its difficulty in the maintenance of the plant—the metal parts having been eaten out several times during the year's experiments.

All other roads report the use of a roundhouse steam blower and the locomotive blower used exclusively.

METHODS OF FIRING UP.

Fourth.—From the reports it would appear that almost every combination of wood, fuel oil, shavings, cobs, coke and bituminous coal had been used, with more serious objections to some than others. Several roads reported extensive trials of coke, but its use has been almost entirely abandoned because the ashes and gases emitted from the smoke jacks are much more objectionable than smoke when roundhouses are located near viaducts or high buildings; furthermore, it is almost impossible for employees to work in the roundhouse when engines have to be moved from under the smoke jacks to do necessary work, and also the cost of coke is greatly in excess of other fuels in most sections of this country.

While the smoke from wood varies considerably in accordance with the size, quality and amount used, still it is more generally employed for kindling fires than any other fuel where the greatest effort is being made to prevent smoke at such times.

APPLY BITUMINOUS COAL CAREFULLY.

Fifth.—The plan of raising steam to nearly working pressure by means of wood or coke alone has been tried by many roads, but abandoned when it was found that the same results could be obtained by adding bituminous coal carefully to the wood fire after the temperature in the fire-box had been somewhat raised.

Sixth.—In general the conclusion is, that although there are many devices for reducing the amount of smoke from locomotives after steam is raised and engines are working, and while it is possible by great care and attention on the part of the roundhouse force to reduce the amount of smoke emitted during this period, at the same time we find no practical way to entirely eliminate all smoke while firing up locomotives at terminals.

Discussion.—This subject proved to be of much interest. It was brought out that the smoke prevention ordinances are now becoming quite general, and in many quarters may be designated as unduly severe. It was fully brought out in this discussion that although objectionable in many ways, wood is about the only material which can be employed for firing-up to reduce the emission of smoke to a minimum. W. E. A. Henry (Penn.), J. W. Fogg (B. & O.), R. D. Smith (B. & A.), C. E. Chambers (C. of N J.), recommended this practice and are using it. The replies of the committee in general indicated where wood was rather scarce, the use of old ties, and especially scrap car wood was in particular favor.

R. D. Smith mentioned that the installation of hot water washout and filling systems at the important terminals of his road has considerably lessened black smoke due to the shortening of the process of firing-up. He believed, as did several other speakers, that careful supervision over the operation and intelligent handling is of material assistance toward the end desired.

T. H. Curtis (L. & N.) commented on the failure of a smoke washing device which had been recommended by the smoke department of Louisville and installed in a roundhouse on that line. This device consisted of a duct connecting the smokejacks to a fan, and from there to a large tube, into which was injected a spray of water, and the washing of the smoke precipitated the carbon, making the smoke much less objectionable. It proved impossible to maintain the device due to the combination of gases and moisture, and it was abandoned.

E. W. Pratt (C. & N. W.), in connection with smoke washing, mentioned that experiments are still under way in that direction, but added that in order to reduce the concentration

of the sulphuric acid in the water that is used to wash the smoke it requires about halt a million gallons per day, which at seven cents a thousand gallons represents about $35 per day for water.

REPORT OF COMMITTEE ON BEST CONSTRUCTION OF LOCOMOTIVE FRAMES

Committee:—H. T. Bentley, Chairman; F. J. Cole, L. H. Fry, G. S. Edmonds, E. D. Bronner.

The committee, called upon to make a report on Locomotive Frame Construction, has given the subject very earnest consideration, and the members who responded so fully to the numerous questions asked furnished valuable data for the committee to work from. At the convention in 1904 this subject was very ably nandled by a strong committee, and notwithstanding the great increase in size of locomotives, the committee's recommendations still hold good and the frames still break.

Cast steel, made to a rational specification, careful foundry manipulation, adequate and suitable annealing, was spoken of as one of the remedies for frame breakages at that time, and it still is the favorite material, if properly designed, made and annealed. The clip binder was then, and is now, more used than probably any other type, the bolt and thimble style having been discarded in modern practice owing to stretch of bolts.

The specifications suggested by the Committtee of Steel-casting Manufacturers, and submitted to the Association in 1904, are as follows:

Material:

Acid open-hearth steel........................ .28 carbon. .05 phosphorus. .05 sulphur. .60 manganese.

Frames will be rejected that show:

Less than .20 or over .35 carbon.
Over .06 phosphorus.
Over .06 sulphur.
Over .70 manganese.

Tensile strength per square inch, not less than 55,000 pounds.
Elongation in 2 inches, not less than 15 per cent.
All frames to be annealed.

After seven years it would be interesting to learn from the members if these specifications are entirely satisfactory, or, if not, what changes should be made to make them so. While the breakage of a frame is a serious handicap, especially during busy seasons, yet the work of repairing has been simplified so that it is now possible to weld them in place with thermit, oil, etc., and what used to be a two weeks' job, when all wheels had to be removed and frame taken to blacksmith shop, can now be repaired in place by dropping one pair of wheels and using oil, etc., and engine returned to service in a few days.

CONCLUSIONS AND RECOMMENDATIONS.

1. That frame breakage is even more general and serious than we were at first led to believe, very few roads being free from this trouble. The longer the wheel base of engine, ordinarily, in combination with a roadbed having comparatively short curves, and with frames poorly designed or of inferior metal, or engines not properly kept up, the greater the trouble will be with frames breaking. This latter factor may not be reflected until after the engine has been put in good condition, and then a frame may finally break as a result of the previous poor condition of the engine.

2. We believe that with frames properly designed, if made of a good quality of cast steel, thoroughly annealed, with suitable cross bracing and engines kept up in reasonably good shape, breakage will practically be overcome.

3. That a cast-steel, one-piece frame, properly designed, of good material and thoroughly annealed, is better than a wrought-iron frame, because of the difficulty in welding up the large section in a perfectly satisfactory manner, and also because, in a casting, bosses, lugs, etc., can be added without the necessity of bolts and studs.

4. That a bar frame is better than a plate frame, this being the opinion of people who have used both: the plate frame causing about as much trouble with breakage in Europe as bar frames do in this country.

5. The strap binder appears to be the favorite form of tying frame jaws together, although the cast-steel box binder, with adjustable wedges, has a number of friends, on account of its simplicity and ease with which it can be handled. The toes at base of jaws should be of sufficient depth and size to give plenty of metal to anchor to, whichever binder is used.

6. Cases have been reported where frame breakage was directly traceable to expansion of boiler not being properly taken care of by the use of sliding shoes; these shoes, if too tightly fitted or cramped in bolting, or if not lubricated, may prove unsatisfactory. Supporting boiler by means of vertical plates, if of sufficient strength, provides a satisfactory means of taking care of expansion without imposing undue strains upon the frames.

7. We would recommend to steel manufacturers the necessity of making a study of locomotive-frame casting, and the proper annealing of same, as a number of roads are using wrought iron, but would prefer steel if they could secure reliable castings.

8. As a general proposition, frame breakage does not ordinarily occur until engine has been in service two years or more, the older the engine the greater the trouble; we have come across cases, however, where they have broken earlier than this on account of flaws, poor welds, or other defects.

ABSTRACT OF REPLIES TO QUESTIONS.

The breakage of locomotive frames appears to be very general, from the nature of replies received, as twenty-four representative roads out of twenty-five stated that they were having trouble in this direction; one road, with only fifty-nine engines, reported no trouble; another says, having some trouble, but nothing serious, while a third replies that, with cast-steel frames, considerable difficulty is experienced. The absence of frame breakage reported by the Trinity & Brazos Valley Railway Co., having fifty-nine engines, led us to write Mr. Seabrook, the superintendent of motive power, and ask if he could explain why he was having no trouble, and also to give us the maximum curvature on the road, and will quote part of his reply:

"We attribute our success in preventing frame breakage to roundhouse attention. The engines are entirely looked after by the roundhouse force. Engineers are not held responsible for the inspection of engines underneath. When an engine arrives at the roundhouse, the inspector makes a very thorough inspection, and every bolt that shows any indication of working is immediately removed, the holes reamed out and a new bolt applied. Whenever it is possible, our practice is to equip each bolt with two nuts. This engine inspector also looks after the setting of wedges and keying up the rods, reporting the work that is necessary to the roundhouse foreman, who assigns the men to make the repairs. The age of engines runs from four to twenty-five years; the worst curve on road is 9 degrees 30 minutes."

In trying to analyze the cause of frames breaking, had to look to the methods that were being adopted to prevent breakage, and found the difficulty was being solved in a number of ways. The binder and bolt appear to be responsible (when not kept tight) for considerable trouble; some roads report that they watch this very closely. Another road is applying new and heavier section to frames that are breaking. Reinforcing frames and lengthening splices is reported as being helpful.

Where wedges are not kept properly in place there will be more liability to frame breakages than where they are kept snug. Splices working will cause strains to be thrown on other parts of frame, and probably cause breakages. Extending the short top-splice back over the front-pedestal jaw has relieved some roads of trouble. The adoption of the Walschaerts, or other outside gear, has probably done more to overcome trouble than anything else, on account of allowing additional bracing and stronger frames. Some roads have increased the thickness of metal in both rails of frames and have applied heavier cross braces. One reply indicated that the movement of driving boxes so that top of box would strike the frame was a bad thing for the frame, and incidentally would think it a bad thing for the engine crew. Revised valve setting, so as to reduce compression, is reported to be helpful. It is stated that applying hammered-iron sections has also overcome the difficulty.

In trying to find how long a frame might run before breakage, we received a number of replies to our question: "Have you any data as to age of frame at time of breakage?" and found that few breakages occurred in less than two years from date engine was built, but after that the breakages became more frequent as age increased; cast-steel frames appear to be more unreliable than forged frames, some of the latter running from four to eight years before giving trouble.

On some roads the change of valve gear from inside to outside, when accompanied by suitable cross bracing, has apparently overcome the difficulty, but in other cases it has been aggravated. It is our judgment that the larger and heavier the power, especially on crooked roads, the more liability there is to breakage.

We were anxious to find out if any particular type or class of engine was causing more trouble than others, but from the replies received would be led to believe that all of the heavier power is more liable to breakage than the lighter engines, which would seem to indicate that the strength of frame has not increased in the same ratio as the power of the engine. The Atlantic, Pacific, Mogul and Consolidated types seem to be giving lots of trouble on the different roads, and engines with inside valve gear appear to be more troublesome than with outside gear: this being probably due to their age and the larger number in service. Cast steel and wrought iron are about

equally used for frames, the former breaking due to poor castings, defects, shrinkages, etc., while the greatest difficulty with the latter is in getting sound welds.

To show the extent that frame breakages occur: one road in the United States had thirty-nine per cent. of the total number of engines passing through the shops with frames broken, so they had to be welded—those, of course, being bar frames—whereas one English road with 1,545 engines, having slab frames, had over ten per cent. of this number broken; but it was stated that frames could now be welded with oxy-acetylene in two or three days, whereas before it used to take them several months to make repairs.

It is stated on excellent authority that cast steel does not have as great life as wrought iron in locomotive frames. On one road the breakages were tabulated, and show that of a certain number of engines the life of the wrought-iron frame averaged 5.9 years, as compared with 5.5 years for cast steel, and that, on account of the great difficulty in getting homogeneous metal, uniformly annealed, wrought iron was preferred. Frame splices, as a general proposition, give lots of trouble, account of working, and several roads are now using a front-frame section which is welded on to the center of front jaw after the old part with splice has been cut off.

One of the members, replying to the question, "Do you have more frames break with inside than with outside valve gear?" was fortunately able to give us some very interesting data on a large number of Consolidation locomotives, all built about the same time; of 228 with inside or Stephenson gear, 16 per cent. gave trouble in one year (November, 1909, to November, 1910), whereas, with the Walschaert gear, of 172 passing through shops in same period, 18 per cent. of them had to have frames welded, and it is probable that the design was responsible for this condition, as we understand, since then, the sections have been increased beyond the amount that is generally recommended by the locomotive builders.

We find that a number of roads are using vanadium-steel frames experimentally, but on account of the short time they have been in service it is not possible to state positively results obtained. One road reports a vanadium-steel frame broken after being in service eighteen months, and another in four months, while another states that two vanadium-steel frames broke in four months.

On account of more engines with inside than with outside valve gears, and because of their greater age, it is only fair to assume that the breakage would be greater on the engines equipped with the Stephenson gear.

The question of cross bracing has been given considerable thought by your committee, and it was found that it was possible, perhaps, to have the frame so rigidly braced that trouble would occur, but that where a bracing was used that permitted a small amount of flexibility, it was better for the engine, as a whole, and the frames in particular. It is recommended in cross bracing, that ties be fastened full length of pedestal jaw, vertically on rear pedestal, of each driving wheel, or as close an equivalent to this design as governing conditions will permit. The thickness of bosses on cast-steel cross-tie braces are to be not less than 1½, preferably 2 times, diameter of bolt used in fastening. All bolts, where possible, to have heads next to castings, to insure full bearing on bolt.

$$\text{Diameter of bolt at thread} = \text{nearest } \tfrac{1}{8}\text{-inch to } \frac{\text{Width of Frame.}}{4}$$

Where size of bolt comes in even sixteenths, the smaller diameter will be used. Body of bolt to be 1-16 inch larger.

As outside gears, with inside cross bracing, have been in use a comparatively short time, it is a difficult matter to say just what effect the cross bracing has had on frame breakage, but replies received in answer to our question No. 12 would seem to indicate that it is beneficial, and your commitee believe it advisable, but are not yet prepared to say what design is best suited for all classes of power. The four-cylinder, balanced locomotive, we believe, will be less liable to frame breakage, because of more uniform turning movement than a two-cylinder engine, but have not been able to get sufficient data to confirm this theory. The fact that all these engines are comparatively new makes it difficult to get much information about them.

It is our recommendation that a one-piece frame be used on all engines with piston valves, preferably with cast-steel filling between cylinders and bumpers, but on slide-valve engines it is usually necessary to resort to a two-piece frame, because of lack of strength at cylinders. For engines having trailing trucks, a slab, spliced to main frame at rear of back drivers, is generally used, and apparently with satisfactory results. With cast steel, a design can often be used that would be impossible in wrought iron. Some of the trouble experienced with cast-steel frames has been due to the attempt to make them exactly the same as if of wrought iron, instead of taking advantage of the greater possibilities of designing and making a satisfactory frame where cast steel is used. We have endeavored to get some comparative costs of cast-steel and wrought-iron frames, but find it very difficult to do so. Some designs of frames, such as those having ribs of different thicknesses, or pedestal fits of increased width, would be almost impossible to make of wrought iron. Very heavy frames over 5 inches in width are extremely difficult to make satisfactorily of hammered iron, and for these reasons cast steel appears to be the only suitable material.

RULES FOR PROPORTIONING LOCOMOTIVE FRAMES.

Would suggest that, wherever possible, the specifications recommended by the American Society for Testing Materials be used, as a casting better suited to the requirements will be furnished. We believe, however, that as an additional safeguard, it would be better to specify how frame castings should be annealed, and would recommend the following:

Steel-frame castings to be annealed must be heated uniformly to 850° C. (1,560° F.). The heat must be applied slowly, so that all castings in all parts of the furnace are approximately the same temperature. As soon as the castings have reached the required temperature the furnace may be opened.

A careful investigation of this matter shows that the stresses locomotive frames are subjected to are very complex, and that it is impossible to fully analyze them in an entirely satisfactory manner. The methods of proportioning, therefore, consist in using a low-fiber stress, derived from the known forces, which gives relatively higher factors of safety than are customary in the design of simpler and more easily calculated structures. If the stresses in locomotive frames were produced only by the internal force of the engine itself, for example, as in the case of a stationary engine, without reference to movement on the track, the problem would be a comparatively simple one. It is altogether probable, then, that the fiber stress of the frames under these conditons could be so accurately predetermined that no breakages would occur, if at all reasonable skill and forethought were exercised in their design.

This simple proposition for the stationary engine is complicated for the locomotive by the conditions under which it is operated. It has to run on all sorts and conditions of tracks, involving frequently great variations in horizontal and vertical alignment, excessive curvature, irregularities due to frogs, switches, etc. The stresses are influenced very materially by the speed at which the locomotive may run, both on straight and curved portions, involving vertical and lateral movements, the first usually due to irregularities of the track and the second to the centrifugal forces in rounding curves or to the swaying and lurching of the engine. Because of the complex nature of the stresses, it is therefore impossible to satisfactorily account for all of them, and it is necessary to make the factor of safety, derived from the known stresses, correspondingly high in order to take care of the unknown stresses.

In building locomotives, it is customary to proportion frames in terms of the cylinder thrust; that is, the area of one cylinder in square inches multiplied by the boiler pressure. The resulting figure is taken for the basis, and this divided by certain constants for different portions of the frame produces frame sections proportional to the size and power of the locomotive. Because of the simplicity and the ease with which proportions like these can be obtained, and on account of the extremely large unknown stress which cannot be satisfactorily accounted for, the difference caused by the center of cylinders and the centers of frames are not usually considered. Assuming cylinder and frame centers of 86 and 46 inches, respectively, then these figures would be increased 60 per cent. by taking into account the increased moments derived from the local dimensions given, but the increase is disregarded because it is nearly proportional in all engines and taken care of in the low constants.

The following approximate rules will produce sections for bar frames, either in wrought iron or cast steel, suitable for modern locomotives:

$$A = \frac{T}{2{,}500 \text{ to } 2{,}700} \quad B = \frac{T}{3{,}000 \text{ to } 3{,}200} \quad C = \frac{T}{4{,}300 \text{ to } 4{,}500}$$

$$D = \frac{T}{1{,}600 \text{ to } 1{,}800}$$

T=Piston thrust (area of cylinder multiplied by boiler pressure).
A=Square inches of sectional area of frame, top of pedestals.
B=Square inches of sectional area of frame, top rail between pedestals.
C=Square inches of sectional area of frame, lower rail between pedestals.
D=Square inches of sectional area of frame, integral single rail at back cylinder-keying lug.

The width of frames is usually made in proportion to the weight and power of the engine. Frames of 6 inches are not uncommonly used for very heavy engines. Most of the important bolts in a frame are vertical. Therefore it is often advisable to increase the width rather than make up the section entirely in depth, because the section is not cut away so much when large bolts are used, and for that reason, where 1⅜ or 1½ inch bolts are used, frames of greater width can be more economically employed than the narrower sections.

The above rules produce frames of slightly larger section than were customary a few years ago. It is interesting to note that a railroad which has been troubled with excessive frame breakage in older engines of light frame sections, has in recent years gone to sections almost equal to those given by the above rules, and in some cases has exceeded the weight and section produced by such rules. It is also significant that, irrespective of transverse bracing or any refined methods of construction, there is a minimum amount of metal which can be safely used in the sections of locomotive frames that cannot be reduced without incurring the risk of breakages sooner or later, when constructed of materials ordinarily available for this purpose.

Frame breakages do not usually occur for some time after the locomotives are placed in service, and in a general way it may be stated that many breakages do not occur until the engines have been in service for at least two years. Probably three or four years is the time when the greater number of fractures commence to occur, and from that time on in increasing numbers. The above is only true in cases where there are no pronounced local defects, such as poor welds, shrinkage, or porous places in steel castings. Where local defects exist, the breakages are apt to occur in a very much shorter period of time, and a number of instances could be given showing that such fractures occur in from three to six months or even shorter time of service.

PLATE FRAMES.

A direct comparison cannot be made between similar construction in service here and abroad, because plate frames are used almost entirely in Europe; therefore, when frame construction in the United States is compared with European frame construction it must necessarily take the form of judging the relative merits of the plate and bar frame construction. A more or less vague impression appears to exist in this country that plate frames are freer from breakage than bar frames; and that although plate-frame construction is not suitable for American engines for various reasons, provided satisfactory designs for heavy locomotives could be made, that foreign railways are not troubled by frame breakages to the extent that we are accustomed to in this country.

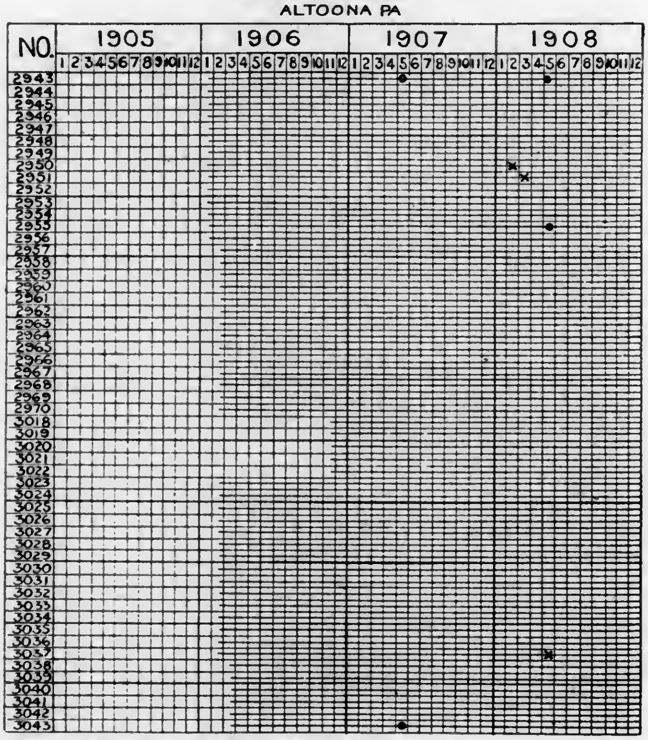
Plate frames are more readily repaired than bar construction, with the possible exception of thermit welds, because a plate on one or both sides can be bolted or riveted which will usually satisfactorily reinforce the broken section. On account of their relatively thin sections, plate frames in some instances are also repaired by means of oxy-acetylene blow-pipe welds. Because of the greater weight and power of American engines, it does not appear practicable to make a satisfactory design of plate frame which will provide the necessary bearing surface for driving boxes. This bearing surface is obtained by fitting and riveting on cast-steel horn blocks or pedestals, in which the number of rivets is such as to reduce the bearing pressure on the rivets to safe limits so there will be but little probability of their working loose: the idea being, that while their use is satisfactory for lighter engines, yet for the greater piston thrusts required on American engines it would be difficult to make a design in which the various parts could be riveted onto the plates in such a secure manner that the annoyance from loose bolts and rivets would not be much greater than with the present bar-frame construction.

The general tendency in the design of railroad rolling-stock is toward simplicity and the elimination of bolted parts, making or casting pieces together and working away as much as possible from built-up construction. From this point of view there does not seem to be much to be gained in the plate-frame construction, although such frames are made from one piece extending from the front to the rear of the engine, yet the pedestal horn blocks, spring fastenings and a number of other attachments are either bolted or riveted on. Compared with the bar frame, which is used exclusively in the United States at present, plate frames are essentially a built-up construction, and in the erecting of an engine using such frames the alignment is much more difficult, involving more care and time, so that the erection of an engine is a longer process than when bar frames are used. This and other causes render plate-frame construction undesirable, in our opinion, as a possible substitute for bar frames. Furthermore, it is a fact that the one-piece, integral-bar frame construction, when made of suitable material, is as free, if not freer, from defects or breakages than plate frames.

From personal observation of a great many locomotives in the principal European countries and from reports obtained from railroad men abroad, the facts seem to be that plate frames often break, especially on the older classes of engines, and that unless made exceptionally heavy above the pedestal they may be expected to show partial or complete fractures after a certain period of service. One English railroad reports that the frequency of broken plate frames may be judged by the fact that three hundred fractures have been repaired within the last two years. Taking into consideration the number of locomotives in use on that road, the average is almost exactly ten per cent. of breakages per year.

One method of computing the maximum stress in plate frames is by supposing that the engine is being wheeled and that it is lifted by cranes from each end with the pedestal binders removed. The weakest part, therefore, is immediately over the middle pedestals. The frames are treated as a beam supported at each end and the load distributed. The resistance of doubtful sections is computed and the depth of plate increased until a factor of safety of between three and four is obtained. Another method is to take the greatest piston thrust and proportion the frame so that the greatest fiber stress resulting does not exceed 1,000 kg. per square centimeter (14,220 pounds per square inch). In calculating this stress, the leverage caused by the distance of center of cylinder from center of axle bearing on the opposite side, the distance of bearings on main axle, as well as the leverage caused by the gap itself, must be considered. One of the disadvantages of plate frames is that they cannot easily be made as accurate nor can the alignment of the working parts be so easily accomplished as with bar frames, where all fitting surfaces are machined. The access to parts under the engine is not so good with plate as with bar frames.

PENNSYLVANIA RAILROAD
LINES EAST AND WEST OF PITTSBURGH
LOCOMOTIVES
RECORD OF FRAME FAILURES
CLASS H6B
ALTOONA PA



X INDICATES BROKEN FRONT FRAME
O " " MAIN "

It may be interesting to give extracts from an article written by Mr. I. Valenziani, of the Italian State Railways, published in *l'Ingegneria Ferroviaria*, for November 1, 1910, which has a bearing on the subject. He says:

"Many European railways have purchased American locomotives, and while some details have been found unsuitable for European practice, it is none the less true that in other respects the American locomotives have given excellent results. Among the details which were largely appreciated in Europe must be included the bar frames, which have two great advantages over the plate frames; namely, the very much greater ease of examination and adjustments of parts lying between the frames, and the greater ease and rapidity with which the various parts can be attached to the frames during the construction of the locomotives. The advantage derived from the greater accessibility becomes still more evident when it is remembered that one of the great objections to the use of four cylinders has been the inaccessibility of the inside machinery. Considerable efforts have been made by the American designers of late years to reduce the difficulties and breakages. The excellent results given by the bar frames on the twenty locomotives purchased by the Italian State Railways from the Baldwin Locomotive Works indicate the success attained in this direction. Very good results have also been obtained by Maffei with bar-frame locomotives for various European railways. Maffei prefers wrought-iron bar frames, forged and welded, while Krupp has cut bar frames for the Baden State Railways from a single rolled plate of sufficient thickness. In addition to the facility

of inspection of the machinery offered by bar frames, they have the advantage of rendering the washout plugs and the five box stay bolts more easily accessible.

"In Europe bar frames are rather more expensive than plate frames to construct, and an extension of their use is attributable rather to this than to any technical reason."

Note.—This is probably due to the fact that the manufacturers are better equipped for manufacturing plate than the bar frame.

Committee.

As an interesting addition to the data contained in this paper, we herewith submit extracts from a report that was made by a representative of a locomotive company, who had been specially detailed to look into the subject of frame failure, but as a committee we do not agree with all his deductions.

"The number of frame failures which occur in the operation of locomotives in service is the cause of very serious delays, and represents at least twenty per cent. of the expenditures necessary to keep an engine in service. On one division of a large road, having 705 engines, the average yearly number is 270 failures. On the other road, in five years, they repaired 786 frames on 197 engines. When the fact that each failure, which is serious enough to require taking down the frame, causes the loss of service of the engine from six to ten days, and an expenditure of $150 to $200, the subject becomes one of first importance.

"A comparison of the types of locomotives in service, which were built prior to the past three or four years, shows that the bracing of the frames has not been carried out as we now believe to be necessary for good service. In an effort to overcome the number of failures, the sections of frames have been made heavier and splices increased in section and bolting power, but with several exceptions, the bracing of frames seems to have received less attention than it deserves. Experience shows that many engines with increased frame sections fail almost as much as they did with the lighter frames.

"The first conclusion is that a good design of bracing is more important than heavy frame sections. The stresses to which frames are subject cannot be calculated, because the conditions of service, together with the load and direction of the forces acting, are constantly changing. Another factor is the condition in which the engine is maintained, as shown by several of the daily reports by roads having engines of exactly the same design on different divisions, some of which give little or no trouble, while other divisions report trouble constantly. An investigation carried out on one road several years ago proved that the frame at first pedestal vibrated 1-16 of an inch, both vertically and horizontally, and that in rounding a curve the bottom of the frame was deflected more than the top, which is the natural conclusion when we consider that the frames are usually braced only to the guide yoke, and knees at the top rail, and a light wrought-iron brace at the bottom rail. It is this twisting action on the frame which causes so many failures in the front leg of the first pedestal, and in the lower rails of the splice connections in consolidation engines, where the distance from the cylinder saddle to the pedestal is short. It seems to make no difference how heavy the frame rails are made, because if no other changes are made the frame will break just the same."

A very simple but effective chart for keeping record of frame breakage and length of time engines are in service before breakage occurs, is furnished by the Pennsylvania Railway, and is submitted herewith; on account of considerable frame trouble experienced, we were able to get very interesting and complete data from the Mechanical Department officials of this road.

Discussion.—As might be expected from a subject carrying such a general appeal, the report was accorded a thorough discussion, and although in the latter little, if any, light was thrown on the main issue, how breakage may be prevented, the remarks of the various speakers were of interest as portraying experiences of different roads and under varying conditions. Although asserted by T. H. Curtis (L. & N.) that the Walschaert gear had much to do with frame failures, this does not seem to be borne out elsewhere, inasmuch that other lines report much trouble in this regard where the Stephenson or some other form of outside gear is used, as with the Walschaert. Experiences, however, are found to be so variable that it cannot be said the addition of cross bracing, made possible by outside motion, has materially improved the situation.

R. L. Ettenger (So. Ry.) mentioned having 250 heavy engines on his road with alloy cast steel frames. These engines have been in service, the oldest six years, and no frame failures have been reported as yet. In connection with the employment of cast steel for this part, William Forsythe made as a motion, which was carried, that the association request the American Society for Testing Materials to investigate this subject and have a committee frame a special specification for cast steel locomotive frames to be presented to the association.

R. D. Smith (B. & A.) believed that a well designed steel frame will not break if the boxes, wedges and shoes are kept up, and this was largely the sentiment of the other speakers. This, with better bracing, as advocated by C. E. Chambers (C. of N. J.), D. J. Redding (P. & L. E.), and G. W. Rink (C. of N. J.), it is believed will hold the general situation of frame failures at least under control until the new specifications are prepared.

STEEL TIRES

Committee:—Lacey R. Johnson, chairman; J. R. Onderdonk, R. L. Ettenger and M. Hogan.

The committee has been without a chairman until very lately, and consequently will give simply a report of progress. Collections of specifications already in use, and information as to the practice on the different railways in the United States, Canada and Great Britain, on the question of handling the purchase of steel tires for locomotives and cars have been collected.

Tabulated statements in connection with this material are given therewith for the information of members. It will be noticed that so far as this continent is concerned, purchasing tires by specification is the exception, whereas, in Great Britain it is the rule. Where specifications are used in America, they are used principally as guides, giving limits in analysis within which the tires should be accepted, and guarding railway companies against accepting tires with facial and contour defects, and a specification has been drawn up for your consideration which, if not entirely satisfactory to the association in its present form, will at any rate serve the purpose of bringing out a discussion and criticism of its different details, and should the committee be continued for another year, it may be possible by next convention to place before you a specification acceptable to the members.

It is considered advisable by the committee that tires for locomotive service should be purchased in three grades, for passenger, freight and switching purposes. A physical drop test is necessary in the opinion of the committee that it is the only true way of knowing exactly what kind of material you have in your tire as it will show up the result of the working and heat treatment in the manufacture of your tires, which the chemical analysis by itself will not do. The test piece for both pulling and analysis should be taken from the tires which have undergone the drop test.

Copies of the specifications received from the different railways, at home and abroad, together with synopses of replies to our correspondence are given below.

Specifications for Steel Tires.

1. *Material.* Steel for tires shall be made by the open-hearth or crucible process.

2. *Classes.* There will be three classes of tires for the different classes of service as follows:

Class 1. Driving tires for passenger engines.
Class 2. Driving tires for freight engines.
Class 3. Driving tires for switching engines and tires for engine-truck, tender-truck, trailer and car wheels.

3. *Chemical composition.*

Class No. 1.	
Carbon, not less than	0.50 per cent.
Phosphorus, not over	0.05 per cent.
Manganese, between	0.50 and 0.80 per cent.
Sulphur, not over	0.05 per cent.
Class No. 2.	
Carbon, not less than	0.65 per cent.
Phosphorus, not over	0.05 per cent.
Manganese, between	0.50 and 0.80 per cent.
Sulphur, not over	0.05 per cent.
Class No. 3.	
Carbon, not less than	0.70 per cent.
Phosphorus, not over	0.05 per cent.
Manganese, between	0.50 and 0.80 per cent.
Sulphur, not over	0.05 per cent.

4. *Finish.* The tires must be free from defects of any kind and finished tires must be accurately machined to the prescribed dimensions of the Master Mechanics' Standard, and rough tires must not be outside the limits of the attached print.

5. *Branding.* The tires shall be distinctly stamped when hot with such brands as the purchaser may require, and in such a manner that these marks shall be legible when the tires are worn out.

6. *Samples for Chemical Analysis.* Drillings from a small test ingot cast with the heat or turnings from a tensile specimen or turnings from a tire (where tires are machined at the works of the manufacturer) shall be used to determine whether the chemical composition of the heat is within the limits specified in Paragraph 3.

When required, the purchaser or his representative shall be furnished an analysis of each heat from which tires are made.

7. *Physical Properties.* The steel for the different classes of service shall meet the following minimum physical requirements:

Class.	Tensile strength lbs. per sq. in.	Elongation per cent. in 4 ins.
(a)	105,000	quotient of 1,550,000 ÷ Tensile strength.
(b)	115,000	quotient of 1,300,000 ÷ Tensile strength.
(c)	125,000	quotient of 1,150,000 ÷ Tensile strength.

8. *Falling Weight Test.* A test tire from each heat represented shall be selected by the purchaser or his representatives, and furnished at his expense, provided it meets the requirements.

8a. The test tire shall be placed vertically under the drop in a running position on a spun foundation with an anvil of at least ten tons weight and shall be subjected to successive blows from a tup weighing 2,000 lbs., falling from heights of 10 ft., 15 ft. and 20 ft. and upwards, until the required deflection is obtained as specified in Paragraph 8b.

8b. The test tire shall stand the drop test described in Paragraph 8a, without breaking or cracking, and shall show a minimum deflection, and it is hoped to present a formula covering this point at the next meeting.

8c. A specimen for the tensile test is to be taken from a tire that has been subjected to a falling-weight test, and it shall be cut cold from the tested tire at the point least affected by the falling-weight test. The tensile test specimen, when cut from a tire that has been subjected to a falling-weight test, shall be cut normal to the radius and parallel to the face.

8d. Should the test tire fail to meet the requirements in any particular, two more test tires shall be selected from the same heat if the manufacturer so desires, and at his expense. Should these two tires fulfil the requirements, the heat shall be accepted.

9. *Inspection.* The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed. All reasonable facilities shall be afforded to the inspector by the manufacturer to satisfy him that the tires are being furnished in accordance with the specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

Discussion.—C. A. Seley (C. R. I. & P.) opposed the use of a destructive test for tires because of the very large number of small orders, where the waste of a destructive test would not be justified.

Geo. L. Fowler asked for information on the reason for recommending these grades of tires. This was explained by the fact that harder tires could be used on freight engines than on passenger, and consequently a longer life would be obtained. The same thing applied to switch engines.

There was considerable discussion on the reasons for shelling out, the general consensus of opinion being that it was due to fault of the manufacture. The committee will report on its investigation of this feature next year.

FORMULAE FOR DIAMETER OF PISTON RODS AND SIZE OF CROSS HEADS FOR LOCOMOTIVES

Committee:—J. A. McRae, chairman; H. C. May, R. L. Ettenger, B. P. Flory.

The committee appointed to present formulæ for the proper diameter of piston rods and sizes of crossheads has obtained data from a number of the largest railroads and from locomotive builders. We find several different formulæ and designs in use which are giving satisfactory results, therefore representative groups of the data obtained are presented instead of recommending only one set of formulæ for each part.

GROUP I.

PISTON RODS.

Let

P equal area for piston × boiler pressure.

S equal fiber stress.

A equal least area of piston rod through key-way.

Allowable working fiber stress in tension, 9,500 pounds per square inch for steel.

Then

$$(1)\quad A = \frac{P}{S}$$

Piston rods to have enlarged fit in piston and in crosshead; ends to be approximately ¼ inch greater in diameter than body of rod.

CROSSHEAD KEY.

Allowable working fiber stress, 17,000 pounds per square inch for spring steel.

The diameter of body of piston rods, based on 9,500 pounds, fiber stress in tension at least area through key-way, with nominal diameter of cylinder and full boiler pressure for simple engines, are shown in Table I. The sizes vary by even ¼ inches.

TABLE I.

DIAMETER OF BODY FOR PISTON RODS.

Cylinder Diameter. In.	Boiler Pressure. 180 In.	190 In.	200 In.	210 In.	220 In.
16	2¾	2¾	3		
16½—17	2¾	3	3		
17½—18	3¼	3¼	3¼	3¼	
18½—19	3¼	3¼	3½	3½	
19½—20	3½	3½	3½	3½	
20½—21	3¾	3¾	3¾	3¾	3¾
21½—22	3¾	3¾	4	4	4
22½	4	4	4	4	4
—23	4	4	4	4	4¼
23½—24	4¼	4¼	4¼	4½	4½
24½—25	4¼	4¼	4½	4½	4½
25½	4¼	4½	4½	4½	

The dimensions of piston rod end for piston rods with body diameter as shown in Table I are given in Table II and Fig. 1.

The dimensions of the crosshead end are given in Table III and Fig. 11.

CROSSHEADS.

The formulæ for figuring crossheads to be used with the above designs of piston rods were not obtained, but drawings of the crossheads were furnished. A standard formula in terms of the diameter of the rod could not be derived to cover all the sizes. The dimensions of the crosshead hubs for cast-steel crossheads of the "alligator" type are given in Table IV and Fig. 3, and will probably answer in lieu of formula.

The limiting bearing pressure for crosshead pins is 4,800 pounds per square inch.

The bearing area of crosshead shoes, designed to be used with the above, are: Top shoes, 7 by 24 inches, and bottom shoes, 5½ by 24 inches, for piston rods 3¼ inches, 3½ inches and 3¾ inches diameter; top shoe, 8 by 24 inches, and bottom shoe, 6 by 24 inches, for piston rods 4¼ inches and 4½ inches diameter.

GROUP II.

PISTON RODS.

Let

P equal pressure per square inch on piston.

D equal diameter of cylinder in inches.

d equal diameter of piston rod.

l equal length of rod between piston-rod center and the center of the crosshead pin.

f equal allowable working compressive stress.

r equal least radius of gyration of rod.

Then

$$(1)\quad f \text{ equals } P\frac{D^2}{d^2}$$

$$(2)\quad d \text{ equals } D\sqrt{\frac{P}{d}}$$

$$(3)\quad P \text{ equals } \frac{d^2 f}{D^2}$$

Under repeated alternate strains allow the compressive stresses given in Table V. (From Pencoyd experiments.)

TABLE V.

$\frac{l}{r} = \frac{4l}{d}$	Steel (70,000 lbs.)	$\frac{l}{r} = \frac{4l}{d}$	Steel (70,000 lbs.)
20	13,360	70	6,520
30	9,540	80	5,940
40	8,380	90	5,300
50	7,760	100	4,680
60	7,120	110	4,220

CROSSHEADS.

The formulæ for cast-steel crosshead hubs used in connection with the above piston rods are shown in diagram Fig. 4.

The allowable working fiber stresses are as follows:

Rod at key-way	12,500	pounds per square inch.
Key = $\frac{d}{4}$ bearing value	40,000	" " " "
Key = 1.4d shear	13,400	" " " "
Hub diameter = 1.6d	28,000	" " " "
X = .6d shear hub	12,000	" " " "
Y = .5d shear rod	9,400	" " " "

GROUP III.

PISTON RODS.

The following formulæ for piston rods are expressed in

terms of the diameter of rod at root of thread on piston end.

Let

P = area of piston × boiler pressure.
A = area of piston rod at root of thread.
d = minimum diameter of piston rod at root of thread.

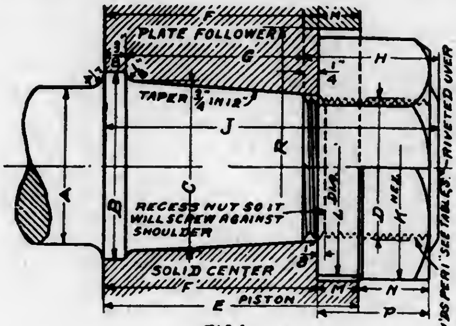


FIG. 1

TABLE II

DIMENSIONS FOR PISTON END OF PISTON ROD.

A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S
2 3/4"	3 1/4"	3"	2 1/2"	4 1/2"	3 3/4"	3 1/8"	2 3/8"	5 7/8"	3 7/8"	3 3/4"	3/4"	1 1/4"	2"	4 3/4"	8
3"	3 1/2"	3 1/4"	2 3/4"	4 1/2"	3 3/4"	3 1/8"	2 3/8"	5 7/8"	4 1/4"	4 1/8"	3/4"	1 1/4"	2"	5 1/4"	8
3 1/4"	3 3/4"	3 1/2"	3"	5 1/2"	4 3/4"	4 1/8"	2 3/8"	6 7/8"	4 5/8"	4 1/2"	3/4"	1 1/4"	2"	5 3/4"	8
3 1/2"	4"	3 3/4"	3 1/4"	5 1/2"	4 1/2"	3 7/8"	2 7/8"	7 1/8"	5"	4 7/8"	1"	1 1/2"	2 1/2"	6"	6
3 1/2"	4"	3 3/4"	3 1/4"	6 1/2"	5 1/2"	4 7/8"	2 7/8"	8 1/8"	5"	4 7/8"	1"	1 1/2"	2 1/2"	6"	6
3 3/4"	4 1/4"	4"	3 1/2"	6 1/2"	5 1/2"	4 7/8"	2 7/8"	8 1/8"	5 3/8"	5 1/4"	1"	1 1/2"	2 1/2"	6 1/2"	6
4"	4 1/2"	4 1/4"	3 3/4"	6 1/2"	5 1/2"	4 7/8"	2 7/8"	8 1/8"	5 3/4"	5 5/8"	1"	1 1/2"	2 1/2"	6 7/8"	6
4"	4 1/2"	4 1/4"	3 3/4"	7"	6"	5 3/8"	2 7/8"	8 5/8"	5 3/4"	5 5/8"	1"	1 1/2"	2 1/2"	6 7/8"	6
4 1/4"	4 3/4"	4 1/2"	4"	7"	6"	5 3/8"	3 3/8"	9 1/8"	6 1/8"	6"	1"	2"	3"	7 1/4"	6
4 1/2"	5"	4 3/4"	4 1/4"	7"	6"	5 3/8"	3 3/8"	9 1/8"	6 1/2"	6 3/8"	1"	2"	3"	7 3/4"	6

S = working fiber stress equals 10,000 pounds per square inch.

Then

$$(1)\quad A = \frac{S}{P} = \frac{P}{10{,}000}$$

$$(2)\quad d = \sqrt{\frac{A}{.7854}}$$

Width of key to be less than d × 1.275.

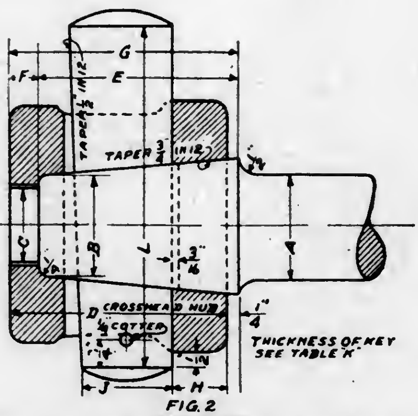


FIG. 2

TABLE III

DIMENSIONS FOR CROSSHEAD END OF PISTON ROD.

A	B	C	D	E	F	G	H	J	K	L
2 3/4"	2 5/8"	1 15/16"	5 3/4"	5 1/4"	3/4"	6"	1 1/2"	2 3/8"	5/8"	9"
3"	2 7/8"	1 15/16"	5 3/4"	5 1/4"	3/4"	6"	1 1/2"	2 3/8"	5/8"	9"
3 1/4"	3 1/8"	2 7/16"	6 1/2"	6"	3/4"	6 3/4"	1 3/4"	2 5/8"	3/4"	9"
3 1/2"	3 3/8"	2 7/16"	6 1/2"	6"	3/4"	6 3/4"	1 3/4"	2 5/8"	3/4"	9"
3 3/4"	3 5/8"	2 15/16"	7"	6 1/2"	3/4"	7 1/4"	1 3/4"	3"	3/4"	10 1/2"
4"	3 7/8"	2 15/16"	7"	6 1/2"	3/4"	7 1/4"	1 3/4"	3"	7/8"	10 1/2"
4 1/4"	4 1/8"	3 7/16"	7 1/2"	7"	3/4"	7 3/4"	2"	3 1/4"	1"	11 1/2"
4 1/2"	4 3/8"	3 7/16"	7 1/2"	7"	3/4"	7 3/4"	2"	3 1/4"	1"	11 1/2"

The dimension for the piston rod in terms of diameter at root of thread on piston end is shown in Fig. 5.

The center part of crosshead fit is reduced 1-32-inch diameter so as to insure having bearing at ends of fit only.

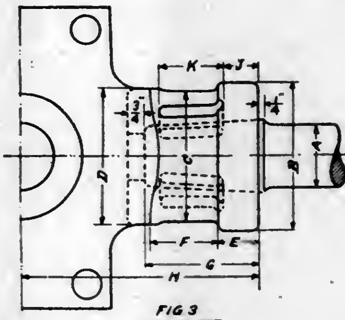


FIG 3

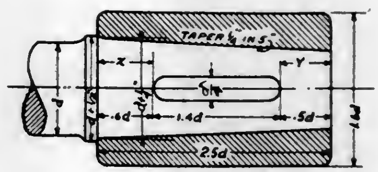
TABLE IV

DIA. OF ROD A	B	C	D	E	F	G	H	J	K
2 3/4" 3"	6 1/2"	5 3/4"	6"	1 3/4"	3"	5"	10 1/2"	1 1/2"	2 13/16"
3 1/4" 3 1/2"	7 1/4"	6 1/2"	7"	2"	3 1/4"	5 3/4"	12"	1 3/4"	3 1/8"
3 3/4" 4"	8"	7"	7 1/2"	2"	3 3/4"	6 1/4"	13"	1 3/4"	3 1/2"
4 1/4" 4 1/2"	9"	8"	8 1/2"	2 1/4"	3 3/4"	6 3/4"	14"	2"	3 3/4"

CROSSHEADS.

The crossheads used with the above piston rods have following dimensions of hubs:

$\frac{d}{2}$ = distance from end of hub to key-way.



Piston pressure × .00003 = thickness of metal in outer end of crosshead hub for cast steel.

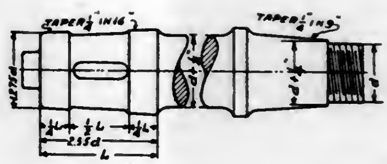
Bearing area in crosshead for crosshead pin = piston pressure divided by 12,000.

The three groups of formulæ are presented as representative of the data obtained.

The committee takes pleasure in acknowledging the assistance of the parties who furnished data.

PISTON RODS AND CROSSHEADS.

Discussion.—W. F. Kiesel (Penn.) stated that 10,000 pounds per square inch was allowed for the maximum pressure in the smallest section of the rod in his office. By the use of large keys and careful workmanship piston rod breakages on rods designed on this basis had been practically eliminated.



Considerable discussion was given the comparative merits of keys and nuts at the crosshead end of the rod. The reports showed the superiority of the design using nuts, although that practice was not apparently very general.

In connection with the use of a shoulder on the rod at the crosshead end, several members criticised the practice strongly, stating that it was practically impossible to get a good fit on both the taper and shoulder.

M. D. Franey (L. S. & M. S.) advised the use of a taper

attachment on a lathe for making the tapers on rods. After turning the fits are simply filed and not ground in. This practice his experience had shown to be entirely satisfactory.

O. C. Cromwell (B. & O.) said in part:

"I do not believe we will ever prevent the breakage of piston rods, when we use a key, if we use the rod long enough. The point should be that we should avoid disconnecting the piston rod from the crosshead, making the rod sufficiently long, so that when you want to renew the packing rings you can disconnect the front end of the main rod and shove the crosshead up against the stuffing box and expose the piston head and renew the ring. My point is to take away the necessity for removing the key and replacing them. We can keep on with sufficient keying to break the rod. That is the direction in which we are working."

F. F. Gaines (C. of G.) found in many of the older and lighter type engines the guides were so light there was undoubtedly a great deal of broken piston rod trouble caused by the springing of the guide allowing flexure. Where the rods were made heavier, in engines which had previously given trouble from that source, it was found that the difficulty was entirely overcome.

THE BEST METHOD OF TREATING WATER FOR LOCOMOTIVE USE, WHEN THE DENSITY OF TRAFFIC DOES NOT WARRANT WATER TREATING PLANTS

Committee:—H. E. Smith, Chairman; F. O. Bunnell, L. H. Turner, J. E. Mechling, J. J. Conners.

Until within a few years, only two methods for the prevention of incrustation in steam boilers have been prominent, namely, boiler compounds and water-softening plants. The former, which include the familiar soda ash, aims to keep the incrusting substances in a soft, pulverulent condition until they can be blown or washed out of the boiler.

In locomotive service one of the difficulties connected with the use of boiler compounds is in applying them proportionally and regularly to all of the water. The plan of putting the matter in the hands of the engine crew was early found to be a failure. The next step was to put the dose for a whole trip into the tender tank at the beginning of a run. This method involves a considerable and possibly harmful excess of compound at the beginning, and a corresponding deficiency near the end of the run. The obvious remedy is to transfer the base of operations from the locomotive to the wayside tank.

To secure this, as well as some other advantages, separate softening plants have been adopted and have easily proved their usefulness. For small stations their use involves the difficulty of high fixed charges per unit of water treated.

The small station must be able to respond to occasional heavy consumption for short periods and a softening plant having sufficient capacity for this purpose becomes expensive during normal times.

A very useful compromise between the two systems of treatment is an apparatus of simple construction which will mix the water uniformly with the proper proportion of some chemical solution which, although it will not actually remove incrusting solids, will act as a boiler compound in keeping them in a soft condition in the boiler. If a fair storage capacity is provided, partial removal of incrusting matter may also be effected.

The work of the committee indicates that few railroad officers realize the importance of this idea or the benefits to be derived from its systematic and intelligent application.

At track-trough stations soda ash (or other material) may be thrown directly into the trough, in regulated quantity, after each train passes. This crude but fairly eeffective method is used on one road at four stations, pending the installation of automatic devices.

Much more systematic is the plan of pumping the solution with the water. This plan is used by seven roads. A small branch may be run from the water-pump suction to a tank of solution and the flow of the latter be regulated by a valve. This method has the advantage of producing a thorough mixture during the passage through the pump, but also sometimes causes deposits on the valves of the pump which interfere with their action. It is found preferable to pump the soda with a small power pump actuated by direct connection with some moving part of the water pump, thus insuring a correct proportional feed of solution. The discharge of the chemical pump should be carried to the large water tank independently of the water. In the water tank the chemical pipe should discharge close to the main water inlet in order to produce satisfactory mixture. As it is not practicable to run the small chemical delivery pipe for long distances, this system is not desirable when the tank is more than 100 feet from the pump house.

When distances are greater the chemical apparatus should be separated from the pump house and transferred to a point close to the water-storage tank or to the top of the tank itself. In such cases, the chemical pump may be actuated by a positive displacement motor or water wheel through which passes all, or a definite aliquot, of the water to be treated. While such a device has long been used in full softening plants, it is not used for the simpler treatment, so far as the committee has learned, except on one road (the L. S. & M. S.). The same arrangement is suitable when water is taken from city supplies where the railway company has no water pumps.

For pumping chemical solutions, simple single-acting outside packed plunger pumps with outside check valves are much to be preferred. Plungers one to two inches in diameter and of six to ten inches stroke are sufficient. Their attachment to any convenient moving part of a water pump is very simple.

The choice of suitable chemicals for the treatment of water under the conditions covered by this report is limited. It is very important to avoid the production of any sediment whatever, or else to provide both time and space in which to separate the sediment entirely. The separation of sediment in the pipes must obviously be avoided.

When sediment must be avoided, as in ordinary wooden tanks when the water is used within two to four hours, soda ash, or possibly bicarbonate of soda is the only reagent available. The latter is least apt to produce sediment. Neither reduces the total amount of incrusting matter, but both change it all to carbonate, or bicarbonates, so that hard scale is largely avoided.

This treatment has been found very beneficial on a number of roads. It is applicable to waters of moderate hardness. With very, very hard waters the amount of soda required to decompose the incrusting matter is liable to cause deposits. In this use of soda ash, as well as with soda ash placed directly in the tender tank, blowing and washing out must be done thoroughly at regular and sufficiently frequent intervals.

In the opinion of the committee the case well merits the small further elaboration of process and apparatus, sufficient to separate a considerable amount of sediment. For this purpose a steel tower, and the use of caustic soda are recommended. With correctly proportioned apparatus and proper adjustment of the soda, a water of twenty or more grains of incrusting solids, of which 25 to 50 per cent. is "permanent hardness," may be reduced to ten grains, of which all is carbonate. In this manner a very troublesome water is reduced to one which will give very successful service, with reasonable care of boilers. So far as the committee is aware, this process is in use only on the Lake Shore & Michigan Southern, although after this report was practically complete it was learned that the Philadelphia & Reading used it some years ago.

One other reagent deserves mention and that is barium hydrate. It has the great advantage of treating sulphates without introducing foam-producing alkali. When sulphate of lime is treated with barium hydrate, the lime ultimately finds its way to the sediment as carbonate of lime and the barium goes the same way as sulphate, insoluble in the water, which is then left entirely free from all the compounds concerned in the reaction. It should be borne in mind that barium hydrate is poisonous. The principal objection to its use is its cost. Not only is its price per pound higher than that of soda ash, but more pounds are required. It has, however, been used by a few roads on very high sulphate waters which could not be treated satisfactorily with soda. Theoretically, three pounds are required to do the work of one pound of soda ash in treating sulphates. In actual work, one road reports that five engines were treated one month with 4,290 pounds of soda ash costing $42.90, but, although this was all that could be used on account of foaming, the boilers were not clean. It was estimated that about twice as much, costing about $85, would have kept the boilers clean if it could have been used. For the same engines 13,000 pounds of barium hydrate, costing $390, was sufficient to keep the boilers clean. It must be borne in mind that these waters are very much worse than the average boiler water of the country.

Finally, it is urged that water purification of any kind should always be supervised by a competent chemist. The raw water should be analyzed occasionally and the chemical solutions, as well as the treated water, should be tested frequently.

Discussion.—Many members spoke in favor of treated water, showing where it had lengthened the life of the boiler besides greatly reducing the item of boiler maintenance. Angus Sinclair drew attention to the necessity of treating different waters in a manner suited to that particular case and not trying to make one dose fit all kinds of water.

J. F. Durn (O. S. L.) favored a boiler compound put into the tender. The compound used is prepared by the chemist after careful analysis of the water in that district.

A. Trumbull (Erie) favored treatment before putting the water into the locomotive tender.

Speaking in answer to questions concerning the foaming of over-treated waters, A. E. Manchester (C. M. & St. P.) said that he had had some experience with the use of barium hydrate as a softening agent which was most satisfactory, but the cost was practically prohibitive.

E. W. Pratt (C. & N. W.) related his experience with over-treated waters, stating that frequent blowing out was the best scheme he had found.

J. Christopher (T. H. & B.) said that some of his engine crews procured castor oil at their own expense and injected it into the water to prevent foaming.

H. E. Smith (L. S. & M. S.), in closing the discussion, said that thorough and constant supervision was very necessary for the best results and would often make a success of a system which without it would cause trouble.

Master Car Builders' Association

Forty-fifth Annual Convention.

(Concluded from page 294, July issue.)*

TRAIN LIGHTING

Committee:—T. R. Cook, Chairman; E. A. Benson, Carl Brandt, Ward Barnum, J. H. Davis.

The committee desires to change the suggestions as to recommended practices given in the report of 1910 to read as follows:

That each electrically lighted car be provided with a notice describing the apparatus in the car, in accordance with the exhibit, and that this notice shall be posted in a conspicuous place in or near the switchboar locker.

That where train line connectors are used, Gibbs' No. 3-G Train Line Connector be used, located as shown on Fig. 1,† with connections to the battery dynamo and jumper as shown on Fig. 2.† If only two wires are used, they shall be connected to the two outside terminals and the female connector on each end of car shall be stenciled "NOT FOR USE ON HEAD END SYSTEM."

That batteries shall be connected up with the positive to the right, facing the car.

That where double compartment tanks are used, the connections and arrangement of battery terminals are to be shown on Fig. 3.‡‡

That each electrically lighted car shall be provided with two charging receptacles with swivel supports, as shown in detail on Exhibits B, C, and D,† installed one on each side of the car as shown on Exhibit E,† the outside angular ring to be the positive.

That each electrically lighted car be provided with two 150-ampere fuses, close-connected to each battery terminal; the fuses to be arranged and placed in a cast-iron box, as shown on Exhibit F,† and installed on car, as shown on Exhibit E.

That each electrically lighted car shall be provided on the switchboard in the car, a switch, fused switch, fuses or terminals. The switches, fuses or terminals to protect and completely disconnect the following parts:

(a) Train line (where train line is used).
(b) Battery.
(c) Axle dynamo (where axle dynamo is used).

(The axle dynamo switch or fuses to control the positive, negative and field of the dynamo.)

Each of the above switches, fuses or terminals to be plainly stenciled, designating the part controlled, the positive terminal to be on the right side facing board.

Where a main lamp switch is used, or where fuses controlling all lamps are used, they shall be so stenciled in plain letters.

That all fuses on cars shall be National Electric Code fuses.

That where axle dynamos are used, negative, positive and dynamo field shall be fused as close as possible to the dynamo and prior to the said leads either entering the conduits or being secured to the bottom of the car. The above fuses to be used for emergency service only and to be at least one hundred per cent. above the capacity of the fuses on the switchboards protecting the same leads.

The following voltages should be used:

60 volts (nominal) for straight storage, head end and axle dynamo systems.
30 volts (nominal) for straight storage and axle dynamo system.

That the batteries shall be preferably installed in double compartment tanks and substantially as shown on Exhibits G, H and I.

That battery boxes shall have provided in each door a vent as shown on Exhibit K.

That when facing the end of the truck on which axle generator is mounted, the pulley or sprocket shall be on the right-hand side.

That the rules of fire underwriters shall cover all car wiring.

That all wiring under car to the switchboard shall be run in conduits.

That a straight pulley seat be provided for the axle pulley. That if a bushing or sleeve be used it must be secured to the axle independent of the pulley. Bushing to have an external diameter of 7½ inches and to be 8½ inches long, turned straight. That the pulley hub have a uniform internal diameter of 7½ inches, the length of the hub to be 6½ inches, the face of the pulley to be 9 inches or wider if flangeless, and 8 inches if flanged. That the generator pulley be flanged, crowned and perforated, and have an 8-inch face.

In connection with Master Car Builders' Rules covering interchange of equipment the committee suggests that the paragraph at the bottom of page 103 reading:

"On electrically lighted cars a battery depreciation charge of 75 cents per day shall be made," be changed to read as follows:

"On electrically lighted cars, furnished to foreign roads, where no agreement is made, the following charge shall be made per day for use of batteries:

	Depreciation.	Current.	Total.
32 cells	46 cents	29 cents	75 cents.
16 cells	23 cents	14 cents	37 cents."

Discussion.—It was explained, in answer to a question by Mr. Wildin, that none of the special devices mentioned in the paper were patented.

G. W. Wildin brought up the matter of recommended voltage of the batteries, 30 volts, stating that this was not suitable for electrified roads, where the current for charging the batteries was taken from the power circuit, and that in case a voltage of 60 was preferable. It was explained by Mr. Cartright, however, that this additional voltage would simply be obtained by adding to the batteries and that the standard now would not affect roads which might be electrified in the future.

The report of the committee was accepted and referred to letter ballot.

J. D. Cartright, of the Lehigh Valley Railroad, chairman of the committee on standards of the Association of Electrical Engineers, was given the privilege of the floor and spoke as follows:

"I am here to present for your consideration the wishes of the Association of Railway Electrical Engineers, primarily formed for the purpose of standardizing as far as possible the electrical equipment on cars. Fully realizing the importance of the subject, I hope you will bear with me for a few moments in the presentation of the subject which will be submitted to you for your consideration. I take this opportunity to thank your committee on train lighting for their hearty co-operation in

* The July issue contained reports as follows: Rules for Loading Material, Revisions of Standards and Practice, Revision of Code of Tests, Coupler and Draft Equipment, Safety Appliances, Train Brake and Signal Equipment, Opening and President's Address, Association Business, Concluding Exercises, Election of Officers.

‡‡ See American Engineer, August, 1910, page 329.

† Not reproduced—copies can be obtained from J. W. Taylor, Sec., 390 Old Colony Bldg., Chicago.—*Ed.*

embodying in their report several recommendations which have been made by our Association. We do, however, take certain exceptions to a few of these recommendations, as follows:

"*Sec.* 1. Should be changed to include additional information not shown.

"*Sec.* 2. The first line, after the word 'used' it was suggested that there should be inserted the words 'they shall be interchangeable with.'

"*Sec.* 5. After the word 'car' in the first line insert the words 'equip with battery boxes.'

"There is no necessity of putting a charging plug on an electrically lighted car that has no battery boxes in it.

Sec. 6. Should read: That each electrically lighted car be provided with two 150-ampere fuses close connected to positive and negative terminals of batteries, at battery box, before wires enter conduit leading to distributing board in car. The fuses to be arranged and placed in a strong metal box, substantially as shown on Exhibit F, and installed on car as shown on Exhibit E.

"*Sec.* 7. Omit the word 'completely' in the fourth line. Also omit the second item. We have found several instances where porters on the cars have pulled the battery switch instead of the light switch. The result is that all the lamps in the car have been burned out, due to the excessive voltage generated.

"The sixth line should read as follows: The axle dynamo switch or fuses to control the positive armature and positive field of the dynamo.

"We had considerable discussion on *Sec.* 10. We wish to eliminate all fuses that we can from a car, consistent with safety. It might be practicable to put a few in your armature, but do not put any in your field or both sides of your armature circle.

"*Sec.* 11 should read as follows: The following voltages should be used:

"For head end or straight storage, 64 volts (nominal).

"For axle dynamo systems, 32 volts (nominal).

"You will notice that we have omitted the recommendation for 30 volts for the straight storage system. On the second part we have omitted straight storage. It was not considered practicable to operate straight storage on 30 volts.

"There is one typographical error which has crept into *Sec.* 17. In the seventh line the figure '7' should be inserted instead of the figure '8,' as the dimensions for the face of the generator pulley.

"At a meeting of the members of the Association of Railway Electrical Engineers, held in Washington on June 16, 1911, it was voted that the recommendations of your committee regarding interchange of electric lighted cars should read as follows: On electrically lighted cars, furnished to foreign roads, where no agreement is made, a charge of 75 cents per car per day shall be made for the use of the electric lighting equipment.

"If any of the suggestions or recommendations that I have made are out of order, I would ask you to excuse my presumption, but accept the recommendations of the Association of Railway Electrical Engineers just the same."

TESTS OF BRAKE SHOES

Committee:—W. F. M. Goss, Chairman; C. D. Young, R. B. Kendig.

PART I.

Brake Shoes.

Status of the Work.—The Association will recall that, as a result of the committee's work prior to the last annual meeting, there was presented at the convention in 1910 a complete series of specifications covering frictional and wearing qualities of brake shoes. These specifications are now the standards of the Association. It was thought at that time that the exensive record of tests then available would make it possible to defer further work upon brake shoes for a time. After a general discussion of the status of the committee's experimental work, however, and especially in view of the significance of the high-speed tests on heavy passenger equipment, the results of which were recorded at the last convention, it was decided to extend the laboratory work for the purpose of securing data under very heavy brake-shoe pressures. It was believed by the committee that such results were necessary for the purpose of settling the question as to whether the standard specifications of the Association are sufficient to protect the purchaser in selecting shoes for the heavy high-speed service referred to.

Outline of Tests as Agreed Upon in December.—Mr. Young, of the committee, was requested to act as a sub-committee to select and deliver to the laboratory samples of shoes used on heavy passenger cars in high-speed passenger service by the New York Central Lines, the Pennsylvania Lines and such other lines as might have shoes to submit.

It was agreed that the frictional qualities and the wear of the shoes submitted should be determined by applications to the 33-inch steel wheel of the Master Car Builders' brake-shoe testing machine in effecting stops at a speed of eighty miles per hour. All tests were to be at this speed, and brake-shoe pressures of 12,000, 14,000, 16,000, 18,000 and 20,000 pounds respectively were to be employed. Each kind of shoe submitted was to be tested in triplicate; that is, three shoes nominally alike were to be subjected to tests for the determination of frictional qualities and wear.

It was agreed that in determining the wear under the foregoing conditions it would be sufficient to weigh the shoes after every three applicatoins. It was understood that between applications the shoe would be cooled to its initial temperature.

It was agreed that no further investigations of wheel wear need be undertaken.

Mr. Kendig, of the committee, was requested to submit a summary of the results of the brake-shoe tests made under his direction in the fall of 1909 on the Lake Shore & Michigan Southern Railway. Professor Schmidt was requested to submit the results of tests then in progress at the University of Illinois, which were designed to ascertain whether there is any material difference in the coefficient of friction as developed by the use of the testing machine when the shoe is applied by weights, as in the Master Car Builders' testing machine, and when applied by means of an air-brake cylinder, as in service.

Axle Loads.—In any study of the possibilities of train braking, the facts concerning axle loads are of importance. It is believed that the following data, showing the actual weight of modern cars used in high-speed passenger service, will be of interest in this connection.

WEIGHTS OF STEEL AND STEEL UNDERFRAME PASSENGER EQUIPMENT CARS.

Type Truck.	Type	R. R. Co.	Weight of both Trucks.	Total Wt. of Car.
6-wheel.	Diner	P. R. R.	42,000	155,000
"	Pullman	C. M. & St. P.	35,000	152,300
"	Parlor-café	B. & O.	42,100	150,600
"	Pullman-Compartment	P. R. R.	......	150,000
"	Pullman-Observation	P. R. R.	......	148,000
"	Pullman-Sleeper	P. R. R.	....	146,000
"	Diner	A. T. & S. F.	45,000	144,000
"	Chair	St. L. & S. F.	36,000	143,000
"	Chair	C. R. I. & P.	41,000	143,000
"	Chair	P. R. R.	......	142,000
"	Diner	C. B. & Q.	40,000	140,700
"	Coach	St. L. & S. F.	36,000	139,000
"	Coach	C. R. I. & P.	41,000	138,900
"	Buffet-Library-Baggage	W. P.	41,700	138,000
"	Coach-Mail	St. L. & S. F.	36,000	137,600
"	Mail-Baggage	St. L. & S. F.	36,000	137,400
"	Coach	C. & O.	42,395	136,615
"	Passenger-Baggage	C. & O.	42,395	136,615
"	Diner	W. P.	42,200	136,200
"	Passenger-Baggage	C. R. I. & P.	41,000	135,800
"	Coach	C. M. & St. P.	35,000	135,000
"	Passenger-Baggage	St. L. & S. F.	36,000	135,000
"	Baggage-Mail	C. R. I. & P.	41,000	133,650
"	Postal	B. & O.	42,100	133,200
"	Baggage	C. M. & St. P.	35,000	129,160
"	Composite	A. T. & S. F.	45,000	129,000
"	Coach	C. M. & St. P.	35,000	128,700
"	Coach	B. & O.	41,200	127,300
"	Chair	C. B. & Q.	40,000	126,400
"	Baggage	C. R. I. & P.	41,000	126,300
"	Passenger-Baggage	P. R. R.	42,560	126,240
"	Baggage	St. L. & S. F.	36,000	126,200
"	Passenger-Baggage	P. R. R.	42,560	124,000
"	Mail	P. R. R.	42,560	124,000
"	Passenger-Baggage	B. & O.	41,200	123,000
"	Chair	A. T. & S. F.	45,000	122,000
"	Baggage-Mail	P. R. R.	42,560	121,000
"	Baggage-Mail	P. R. R.	42,560	120,000
"	Coach	A. T. & S. F.	45,000	120,000
4-wheel.	Coach	P. R. R.	......	119,000
"	Coach	P. R. R.	27,515	117,425
"	Buffet-Library-Baggage	W. P.	32,000	115,800
6-wheel.	Baggage	C. B. & Q.	40,000	113,900
"	Coach	Southern	......	110,100
"	Baggage	A. T. & S. F.	45,000	110,000
"	Baggage	B. & O.	42,100	109,000
"	Postal	M. P.	43,000	107,680
4-wheel	Mail	N. Y. C. Lines.	......	107,000
"	Baggage	N. Y. C. Lines.	......	106,000
"	Baggage	W. P.	32,000	102,500
"	Baggage	N.Y. C. & H. R.	28,145	101,240
"	Baggage	N.Y. C. & H. R.	28,040	101,135
"	Baggage-Mail	N. O. & N. E.	17,040	101,000
"	Coach	L. V.	28,150	100,045
"	Mail-Storage	P. R. R.	......	94,300
"	Baggage-Mail	C. C. & O.	......	93,200
"	Baggage	P. R. R.	......	93,000
"	Passenger	P. R. R.	25,320	86,930
"	Postal	C. R. I. & P.	26,000	86,200
"	Elec.-Baggage-Passenger	Long Island	30,225	83,235

It will be noted that the eight-wheel passenger coach of the Pennsylvania Railroad, weighing 119,000 pounds, gives the heaviest load per wheel, namely, a load of 14,875 pounds. Under the usual service applications the brake-shoe pressure would, of course, be less than this amount and could not, in the light of our present experiments, be regarded as excessive; but with modern equipment, in emergency applications, the brake-shoe pressure upon such a car may readily exceed 20,000 pounds.

Performance of Shoes Under Test as Set Forth in the Accompanying Report by Dean Benjamin.—The desire of the committee to determine whether shoes would resist pressures as great as 20,000 pounds, in making stops from a speed as high as eighty miles an hour, has been fully satisfied. The detailed report of tests shows the precise results obtained as to co-

efficient of friction and wear from a considerable number of shoes when tested under the several different pressures up to and including 20,000 pounds. It is formally reported to your committee also that tests made at the laboratory of the University of Illinois have involved, without serious difficulty, brake-shoe pressures as great as 24,000 pounds. If it be assumed that a shoe in such service will rarely be called upon to withstand the conditions of an emergency stop from a speed as high as eighty miles an hour, it may also be assumed that shoes such as those tested may be regarded as reliable for such service. It is of the highest importance, however, to know that the value of the coefficient of friction decreases as the pressure upon the shoe is increased. So great is this change in the coefficient of friction for some shoes that the length of stop is reduced but slightly by increasing the pressure from 18,000 to 20,000 pounds. On the other hand, the wear of all shoes increases rapidly with increase of pressure.

The tests were made at a speed of eighty miles an hour, and since the previous work of the committee does not involve such speeds, it has been impossible to tie up the results of the present series with those which have already been made of record by the committee. For this reason, it is impossible to judge from them the sufficiency of the present specifications for use in selecting shoes for very high-speed service. It has been suggested that in all probability a shoe which gives the best results under the present specifications will at least give good results under the higher speeds and pressures, such as are now being considered. Under the circumstances, it was thought best to present the results as obtained for the information of members, in the hope that later a series of tests may be made under heavy pressures at different speeds, which will permit such results to be connected with those underlying the present specifications.

Coefficient of Friction as Determined Upon a Brake-shoe Testing Machine When the Shoe Is Applied by Weights and by Air.—By the courtesy of Professor Schmidt, the University of Illinois undertook to determine the effect upon the coefficient of friction as found by experiment when the shoe was quickly applied, as by weight, and when more slowly applied, as by air. The purpose of this inquiry was to settle the question as to whether results obtained on the testing machine were the same as those which would be expected under service conditions on the road, conditions of speed and pressure, of course, being the same. The following brief report from Mr. A. S. Williamson, giving the results of such tests, may be accepted as conclusive evidence that the results are substantially the same in both cases:

Dean W. F. M. Goss, Chairman of the Brake-shoe Committee, Master Car Builders' Association:

DEAR SIR,—Responding to the request of the Brake-shoe Committee, tests have been made upon the brake-shoe testing machine of the University of Illinois, in the course of which the shoe has been dropped upon the wheel through the action of weights, and also by use of an arrangement of air equipment giving substantially the conditions of service. These tests were made with a great variety of shoes and under many different conditions of speed and pressure. Within the limits involved by these experiments, the mean coefficent of friction is practically independent of the manner in which the shoe is applied. The following results are typical:

"DIAMOND S" SHOE—Speed, 60 M. P. H.

Shoe Pressure.	Coefficient of Friction.
6,840 pounds	13.95 (weights)
6,840 pounds	14.15 (air)
12,000 pounds	12.25 (weights)
12,000 pounds	12.50 (air)

The facts are perhaps better shown by means of Fig. A, giving the records obtained from the brake-shoe testing machine for the two methods of application, all under conditions as nearly as possible identical. The similarity of the coefficient of friction in the two cases is shown in the upper of the three diagrams. The middle diagram shows a comparison of the pressures, and the lower diagram the retarding effect during the application, all, of course, applying to the same stop.

(Signed) A. S. WILLIAMSON.

Recommendations.—In concluding the summary of the work of the past year, your committee would recommend:

1. That some further work be undertaken by the Association for the purpose of connecting the results obtained under high brake-shoe pressures with those upon which the Association's specifications are based.

2. That in the specifications of the committee, as presented in the report of 1910, paragraphs "c" and "f" be changed to read "steel or steel-tired wheel," instead of "steel-tired wheel."

The formal report of the tests which have been made under the direction of the committee during the current year is as follows:

Dean W. F. M. Goss, Chairman, Brake-shoe Committee, Master Car Builders' Association, Urbana, Ill.:

DEAR SIR,—I take pleasure in transmitting herewith Professor Endsley's report on the tests of fourteen brake-shoes, authorized by your committee. I do not know that I can add anything to the report itself which, it seems to me, brings out all the points of interest. I would like, however, to voice my

TABLE I.

INITIAL SPEED 80 MILES PER HOUR. BRAKE SHOE PRESSURE 12000 POUNDS.

NO OF SHOE	DESIGNATION OF SHOE	STANDARD OF	COEFFICIENT OF FRICTION		LOSS per 100000000 FT POUNDS OF WORK DONE—IN POUNDS	
			EACH SHOE	AVERAGE FOR EACH KIND	EACH SHOE	AVERAGE FOR EACH KIND
I	II	III	IV	V	VI	VII
333	CONGDON	B. & O.	9.96	9.60	1.92	1.65
336	CONGDON	B. & O.	9.24		1.38	
339	PLAIN CAST IRON	PENN.	8.19	8.22	5.88	5.14
340	PLAIN CAST IRON	PENN.	8.25		4.40	
345	SPEAR-MILLER	C.B & Q.	9.67	9.98	4.15	3.95
346	SPEAR-MILLER	C.B & Q.	10.30		3.76	
351	NATIONAL	C.M. & St.P.	7.97	8.73	3.15	3.28
352	NATIONAL	C.M & St.P.	9.50		3.41	
357	DIAMOND-S	SOU. PACIFIC	9.53	9.72	2.49	2.09
358	DIAMOND-S	SOU. PACIFIC	9.91		1.68	
367	U-SHOE	NYC. LINES	9.44	9.60	4.62	4.36
368	U-SHOE	NYC. LINES	9.76		4.10	
376	PITTSBURG		19.70	19.75	3.50	2.87 *
377	PITTSBURG		19.80		2.25	

* ACTUAL LOSS IN WEIGHT HAS BEEN MULTIPLIED BY 2.20 WHICH IS THE RATIO OF CAST IRON TO THE ABRADED PARTS OF THIS SHOE. F.E.E.

TABLE II.

INITIAL SPEED 80 MILES PER HOUR. BRAKE SHOE PRESSURE 14000 POUNDS.

NO. OF SHOE	DESIGNATION OF SHOE	STANDARD OF	COEFFICIENT OF FRICTION		LOSS per 100000000 FT. POUNDS OF WORK DONE—IN POUNDS	
			EACH SHOE	AVERAGE FOR EACH KIND	EACH SHOE	AVERAGE FOR EACH KIND
I	II	III	IV	V	VI	VII
333	CONGDON	B. & O.	9.32	9.08	2.66	2.18
336	CONGDON	B. & O.	8.85		1.79	
339	PLAIN CAST IRON	PENN.	9.45	9.22	4.94	4.57
340	PLAIN CAST IRON	PENN.	9.00		4.20	
345	SPEAR-MILLER	C.B. & Q.	9.15	9.47	4.36	4.42
346	SPEAR-MILLER	C.B & Q.	9.80		4.48	
351	NATIONAL	C.M & St.P.	8.93	8.99	3.44	3.03
352	NATIONAL	C.M & St.P.	9.05		2.62	
357	DIAMOND-S	SOU. PACIFIC	9.60	9.55	3.21	2.90
358	DIAMOND-S	SOU. PACIFIC	9.51		2.60	
367	U-SHOE	NYC. LINES	9.82	9.27	3.80	3.78
368	U-SHOE	NYC. LINES	8.72		3.76	
376	PITTSBURG		18.30	18.75	3.20	2.90 *
377	PITTSBURG		19.20		2.60	

* ACTUAL LOSS IN WEIGHT HAS BEEN MULTIPLIED BY 2.20 WHICH IS THE RATIO OF CAST IRON TO THE ABRADED PARTS OF THIS SHOE. F.E.E.

own opinion that the tables and curves show pretty conclusively that there is nothing particular to be gained either in friction or wear by carrying pressures beyond 18,000 pounds. By reference to Figs. 15, 16 and 17, it is easily seen that the coefficient of friction drops rapidly between 18,000 and 20,000 pounds pressure, and that the amount of wear is correspondingly greater, while the stopping distance, of course, is not materially diminished.

C. H. BENJAMIN.

Dean C. H. Benjamin, Purdue University:

DEAR SIR,—I submit herewith a report of tests of brake-shoes made for the Brake-shoe Committee of the Master Car Builders' Association.

The tests were conducted upon the Master Car Builders' brake-shoe testing machine, a description of which will be found in the Proceedings of the Association for 1894 and 1906.

The shoes tested were of seven different kinds. Six shoes of each kind were received at the university, and of this number two of each type, making fourteen shoes in all, were tested. None of the shoes had been in service prior to their receipt at the laboratory. All of the shoes were given a laboratory number.

Schedule of Test.—So far as practicable, each shoe was tested upon a steel-tired wheel under the following brake-shoe pressures: 12,000, 14,000, 16,000, 18,000 and 20,000 pounds, the initial speed of the machine being in each case eighty miles per hour. At each of the above pressures nine stops were made.

Method of Testing.—In anticipation of a test, the shoe was given a number of applications until a full bearing surface was obtained, after which it was accurately weighed upon a pair of scales. The shoes were first tested at a pressure of 12,000 pounds, after which the pressure was increased by increments of 2,000 pounds until a pressure of 20,000 pounds was reached, or until the shoe broke or became unserviceable.

The loss in weight of the shoe was obtained by weighing the shoe after each three applications, thus giving a check upon the loss for each pressure. During the nine applications at each pressure, three cards were taken from which the coefficient of friction was obtained. It will be seen that some of the shoes

TABLE III.

INITIAL SPEED 80 MILES PER HOUR. BRAKE SHOE PRESSURE 16000 POUNDS.

NO. OF SHOE	DESIGNATION OF SHOE	STANDARD OF	COEFFICIENT OF FRICTION		LOSS per 100000000 FT. POUNDS OF WORK DONE—IN POUNDS	
			EACH SHOE	AVERAGE FOR EACH KIND	EACH SHOE	AVERAGE FOR EACH KIND
I	II	III	IV	V	VI	VII
333	CONGDON	B. & O.	8.80	8.68	2.92	2.36
336	CONGDON	B. & O.	8.56		1.80	
339	PLAIN CAST IRON	PENN.	9.34	9.19	5.06	4.58
340	PLAIN CAST IRON	PENN.	9.04		4.10	
345	SPEAR-MILLER	C.B. & Q.	8.15	8.42	5.06	5.03
346	SPEAR-MILLER	C.B. & Q.	8.70		5.01	
351	NATIONAL	C.M. & St.P.	8.60	8.67	5.02	4.00
352	NATIONAL	C.M. & St.P.	8.75		2.99	
357	DIAMOND-S	SOU. PACIFIC	8.46	8.73	4.20	3.44
358	DIAMOND-S	SOU. PACIFIC	9.01		2.68	
367	U-SHOE	NYC. LINES	8.96	8.72	4.98	4.94
368	U-SHOE	NYC. LINES	8.47		4.98	
376	PITTSBURG		17.20	17.75	2.94	2.54 *
377	PITTSBURG		18.30		2.14	

ACTUAL LOSS IN WEIGHT HAS BEEN MULTIPLIED BY 2.20 WHICH IS THE RATIO OF CAST IRON TO THE ABRADED PARTS OF THIS SHOE. F.E.E.

TABLE IV.

INITIAL SPEED 80 MILES PER HOUR. BRAKE SHOE PRESSURE 18000 POUNDS.

NO. OF SHOE	DESIGNATION OF SHOE	STANDARD OF	COEFFICIENT OF FRICTION		LOSS per 100000000 FT. POUNDS OF WORK DONE—IN POUNDS	
			EACH SHOE	AVERAGE FOR EACH KIND	EACH SHOE	AVERAGE FOR EACH KIND
I	II	III	IV	V	VI	VII
333	CONGDON	B. & O.	9.20	8.57	2.81	2.56
336	CONGDON	B. & O.	7.95		2.32	
339	PLAIN CAST IRON	PENN.	9.15	8.70	4.76	4.65
340	PLAIN CAST IRON	PENN.	8.25		4.54	
345	SPEAR-MILLER	C.B. & Q.	7.47	7.67	10.30	7.76
346	SPEAR-MILLER	C.B. & Q.	7.88		5.22	
351	NATIONAL	C.M. & St.P.	7.68	7.68	6.16	6.16
352	NATIONAL	C.M. & St.P.				
357	DIAMOND-S	SOU. PACIFIC	9.17	8.86	4.09	4.03
358	DIAMOND-S	SOU. PACIFIC	8.55		3.98	
367	U-SHOE	NYC. LINES	8.45	8.45	5.85	5.85
368	U-SHOE	NYC. LINES				
376	PITTSBURG		17.40	17.10	2.91	2.65 *
377	PITTSBURG		16.80		2.40	

ACTUAL LOSS IN WEIGHT HAS BEEN MULTIPLIED BY 2.20 WHICH IS THE RATIO OF CAST IRON TO THE ABRADED PARTS OF THIS SHOE. F.E.E.

failed before the pressures of 18,000 and 20,000 pounds had been reached.

Between each application the shoe was cooled by a blast of air until the temperature was reduced to such an extent that the observer could bear his hand upon the shoe. This required from twenty-two to twenty-eight minutes between each application.

Results Obtained.—The results obtained are given in Tables I to VI, inclusive.

Table I gives the results obtained at a brake-shoe pressure of 12,000 pounds. Col. I of this table gives the number of the brake shoe; Col. II, the designation of the shoe; Col. III, the road on which it is standard; Col. IV, the coefficient of friction of shoe; Col. V, the average coefficient of friction of the two shoes of the same kind; Col. VI, the loss for each 100,000,000 foot-pounds of work done for each shoe; Col VII, the average loss per 100,000,000 foot-pounds of work done for the two shoes of each kind.

Table II gives results obtained at 14,000 pounds pressure.

Table III gives results obtained at 16,000 pounds pressure.

Table IV gives results obtained at 18,000 pounds pressure.

Table V gives results obtained at 20,000 pounds pressure.

In Tables II to V the notations for the columns are the same as for Table I.

Table VI gives the approximate distance per stop in feet as obtained from the three cards taken at each pressure for the two shoes of each kind. Col. I of this table gives the number of the brake shoe; Col. II, the designation of the shoe; Col. III, the road on which it is standard; Col. IV, the approximate distance in feet during the stop at a pressure of 12,000 pounds; Col. V, the approximate distance in feet during the stop at a pressure of 14,000 pounds; Col. VI, the approximate distance in feet during the stop at a pressure of 16,000 pounds; Col. VII, the approximate distance in feet during the stop at a pressure of 18,000 pounds; Col. VIII, the approximate distance in feet during the stop at a pressure of 20,000 pounds.

Fig. 1 gives the average coefficient of friction of each kind of shoe tested, plotted against the brake-shoe pressure.

TABLE V

INITIAL SPEED 80 MILES PER HOUR BRAKE SHOE PRESSURE 20000 POUNDS

NO. OF SHOE	DESIGNATION OF SHOE	STANDARD OF	COEFFICIENT OF FRICTION		LOSS per 100000000 FT. POUNDS OF WORK DONE—IN POUNDS	
			EACH SHOE	AVERAGE FOR EACH KIND	EACH SHOE	AVERAGE FOR EACH KIND
I	II	III	IV	V	VI	VII
333	CONGDON	B. & O.	7.25	7.25	3.64	3.30
336	CONGDON	B. & O.	7.25		2.97	
339	PLAIN CAST IRON	PENN.	7.04	7.21	6.94	6.50
340	PLAIN CAST IRON	PENN.	7.39		6.06	
345	SPEAR-MILLER	C.B. & Q.		8.30		12.20
346	SPEAR-MILLER	C.B. & Q.	8.30		12.20	
351	NATIONAL	C.M. & St.P.	6.87	6.87	10.93	10.93
352	NATIONAL	C.M. & St.P.				
357	DIAMOND-S	SOU. PACIFIC	6.77	7.02	5.80	5.94
358	DIAMOND-S	SOU. PACIFIC	7.27		6.08	
367	U-SHOE	NYC. LINES	7.34	7.34	5.71	5.71
368	U-SHOE	NYC. LINES				
376	PITTSBURG		15.35	15.27	4.97	4.54 *
377	PITTSBURG		15.20		4.11	

* ACTUAL LOSS IN WEIGHT HAS BEEN MULTPLIED BY 2.20 WHICH IS THE RATIO OF CAST IRON TO THE ABRADED PARTS OF THIS SHOE. F.E.E.

TABLE VI.

INITIAL SPEED 80 MILES PER HOUR.

NO. OF SHOE	DESIGNATION OF SHOE	STANDARD OF	APPROXIMATE DISTANCE PER STOP IN FEET UNDER THE FOLLOWING BRAKE SHOE PRESSURES				
			12000	14000	16000	18000	20000
I	II	III	IV	V	VI	VII	VIII
333, 336	CONGDON	B. & O.	2205	2070	1791	1600	1648
339, 340	PLAIN CAST IRON	PENN.	2472	1995	1755	1595	1656
345, 346	SPEAR-MILLER	C. B. & Q.	2495	2010	1910	1805	1424
351, 352	NATIONAL	C. M. & St. P	2403	2050	1835	1730	1698
357, 358	DIAMOND-S	SOU. PACIFIC	2261	1925	1801	1551	1633
367, 368	U-SHOE	N.Y.C. LINES	2167	1964	1771	1660	1598
376, 377	PITTSBURG		1037	932	852	755	735

F.E.E.

Fig. 2 gives the average loss per 100,000,000 foot-pounds of work done for each kind of shoe, plotted against the brake-shoe pressure.

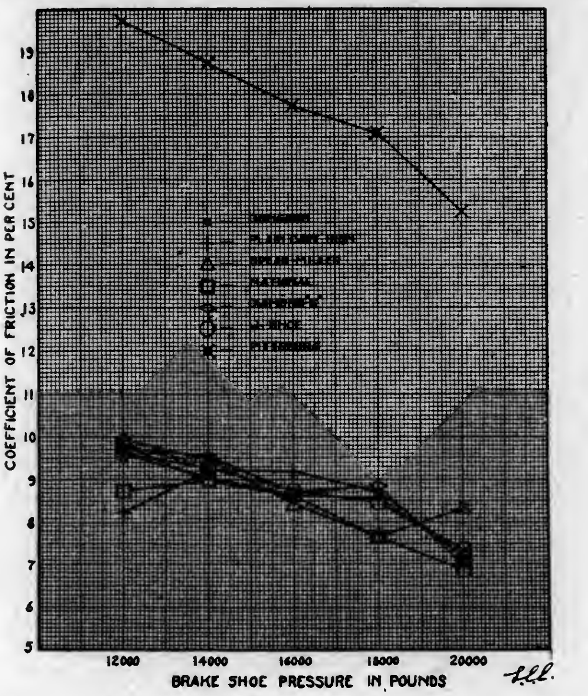
Fig. 3 gives the approximate distance per stop in feet for each kind of shoe, plotted against the brake-shoe pressure.

It will be seen from Fig. 1 that the coefficient of frictoin of all but two kinds of shoes tested decreased as the pressure increased, the two exceptions being the "plain cast-iron shoe" and the "National shoe." This is no doubt due to the fact that the composition of the outside layer of the shoe is not of the same texture as the inner layer, or that the heating and cooling of the shoe changed the material in such a way as to affect the frictional qualities. Also, it will be seen from Fig. 15 that the loss due to wear is increased as the pressure is increased in all but three kinds of shoes. These are the "plain cast-iron," the "National" and the "U" shoe. Two of these kinds of shoes are the ones which showed the inconsistency in the coefficient of friction.

In order to check these seeming inconsistencies, either in the wear or frictional qualities, three shoes, one of each kind mentioned above, were again tested at 12,000 pounds pressure after the tests at 18,000 pounds pressure had been conducted. The results from these retests are given as dotted lines in the curves shown in Figs. 1 and 2. It will be seen from these dotted lines that in each case the seeming inconsistency practically disappeared, showing that tests of the outside layer of a shoe will not in all cases give similar results to tests of the inner material.

It will be seen from the results shown in Fig. 1 that the points representing coefficient of friction for all shoes, except one, fall close together, there being less than two per cent. variation in any two sets of shoes. The one exception is the "Pittsburg" shoe, which is a composition shoe, and gave practically twice the coefficient of friction obtained from any of the other shoes.

The results shown in Fig. 2 indicate that the wear is not uniform for the different makes of shoes, it varying from about 1.5 to over 5 pounds per 100,000,000 foot-pounds of work done



at 12,000 pounds pressure and from about 3.5 to over 12 pounds at 20,000 pounds pressure. It will be also seen from Fig. 2 that the loss is not much increased until a pressure of 18,000 or 20,000 pounds is reached.

The results shown in Fig. 3 show that the distance per stop is about the same for all shoes but one, this shoe being the "Pittsburg" shoe, which gave the highest coefficient of friction. Three of the shoes tested stopped the wheel in a less distance of 18,000 pounds than at 20,000 pounds, and three of the other four shoes gave almost the same results at 18,000 as at 20,000 pounds. The only shoe that showed much advantage at 20,000 pounds over that at 18,000 pounds was the "Spear-Miller." This shoe became very hot and gave off a flame three or four feet long resembling a gas flame during the stop at 20,000 pounds pressure.

Louis E. Endsley.

PART II.

Brake Beams.

Changes in Drawing of Break Head.—The committee desires to recommend certain changes in the drawing of the standard brake head as shown on Sheet M. C. B. 17.

1. The dimensions of the upper-hanger hole have been made the same as the dimensions of the lower-hanger hole, to permit the use of the 1-inch hanger. This change was omitted from the drawing last year through error.

2. The inclination of 15/16 inch in 6⅛ inches, as shown on the side elevation of the head on Sheet M. C. B. 17, is correct for the brake beam hung 14 inches above the rail, but is not correct for the standard 13-inch hanging for inside-hung beams. The drawing has been corrected to show an inclination of 1 9/32 inches in 6 inches, to correspond to the 13-inch hanging, and all the vertical dimensions have been made to read from a line drawn through the center of the bottom hanger-hole and the center of the wheel. The contour of the head has not been changed in doing this.

3. The ribs bracing the under side of the lower shoe-bearing lug have been removed from the drawing, as these ribs are not actually being used on the heads to-day.

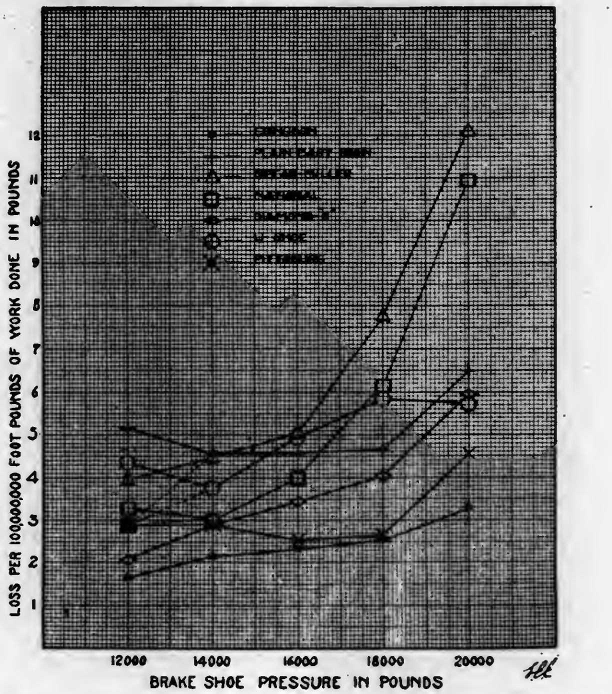
4. Sheet M. C. B. 17 shows a ⅝-inch radii at the ends of the shoe-bearing lugs, and the committee believes this only results in less bearing area and is of no value, and accordingly the drawing has been changed to show a ⅛-inch radius at this point and the side of the lug has been slightly tapered.

The committee recommends the adoption of these changes, which we believe to be improvements in the design of the head, without affecting its interchangeability with heads and shoes now in service.

Review of Recommendations 4 and 5 of the 1910 Report.—Among the several recommendations made by the committee at last year's convention there were two, numbers 4 and 5, which were rejected on the letter ballot. They are as follows:

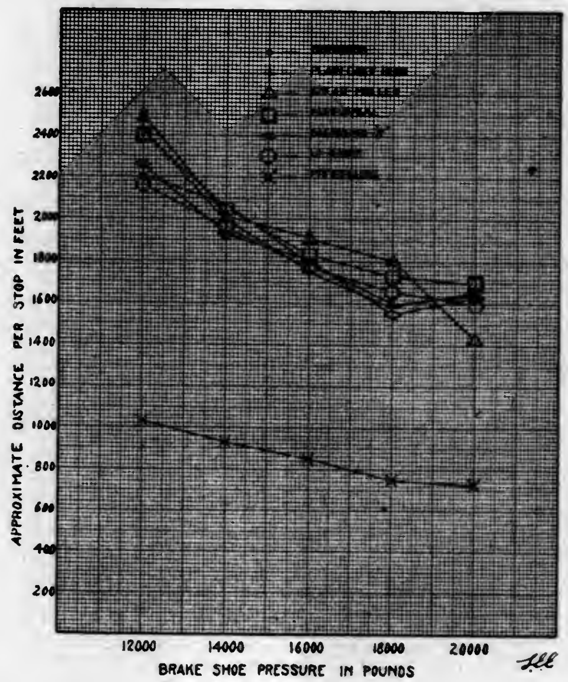
"That all No. 2 beams used on cars built after January 1, 1908, shall be of such dimensions that all parts of the beam will lie within the outline shown in Fig. 10 of this report; and that this outline be shown among the standard drawings.

"That on page 591 of the Proceedings for 1909, the seventh paragraph, relating to beam No. 2, be changed to read: 'Beam



No. 2 must be used on cars of more than 35,000 pounds light weight, and it may be used on cars of 35,000 light weight or less.'"

For the purpose of ascertaining the reason for the objection to these two recommendations, the committee early issued to the membership of the Association a circular of inquiry, asking the roads which voted against these propositions to state their reasons to the committee. The purpose of this procedure was to secure for the committee such information as would



permit it to modify the recommendations so as to make them acceptable to the objecting roads. A meager response, only, was returned.

Some of the suggestions received in reply to this circular are conflicting, but they have all been combined, as far as possible, to form a new diagram as is shown in Fig. 19.

The principal points raised related:

1. To the distance from the face of the brake head to the back of the beam, which has been changed from 5½ inches to 5 inches.

2. With steel or steel-tired wheels, which may be reduced to 30 inches in diameter, there is danger with a deep beam of having the fulcrum striking the axle.

3. The location of the diagonal lines limiting the tension members of the beam has been changed to avoid confliction with some beams which are now in service.

The diagram shown in Fig. 19 is submitted for the consideration of the members with the same recommendation with which the diagram was submitted last year.

Having presented the discussion so far as it could be developed, your committee would resubmit for discussion recommendations 4 and 5 as above given, with the request that they be so modified at the convention as to make them acceptable to the members.

Discussion.—The first part of this report brought out some discussion in the shape of request for information concerning the variation of axle weight on the testing machine. It was explained that there was no variation in this weight for the different tests.

The recommendations of the committee that further work be undertaken were referred to the executive committee, and the secretary was instructed to change the reading in paragraphs "c" and "f" to "steel or steel tired wheels," instead of "steel tired wheels."

Attention was drawn to the fact that an error had been made in the report in connection with the radius of the fillet in paragraph 4 under brake beams. This should be ⅛ in. insead of 1-16 in. as shown. The recommendations of the committee were adopted and submitted to letter ballot.

REFRIGERATOR CARS

Committee:—M. K. Barnum, chairman; J. S. Chambers, G. W. Lillie, W. E. Sharp, E. Posson, W. C. Arp, R. S. Miller.

The Uniform Height of Refrigerator Cars from the Rail to the Floor.

Our investigation of this subject shows that a large majority of the refrigerators built within the last ten years or more have the height of floor varying between 48 inches and 50 inches above the rail, but the Santa Fe Refrigerator Dispatch has some six thousand cars with floors approximately 46½ inches above the rail. We have not been able to learn of any cars which have the floor at 42 inches above the rail, as stated in the Railroad Refrigerator Service Association Circular No. 84, dated June 26, 1909.

We also find that all freight-house platforms of the largest roads and packing-houses vary in height from 42 inches to 46 inches above the rail, and understand that the American Railway Engineering and Maintenance of Way Association has not yet adopted any standard height for freight-house platforms; we therefore suggest that the Master Car Builders' Association adopt a minimum of 48 inches as the recommended practice for refrigerator-car floors, and that the matter be taken up with the American Railway Engineering and Maintenance of Way Association with the view of having them adopt 46 inches as the maximum height of freight-house platforms, as we believe that this will make ample allowance between the bottom of refrigerator doors and top of platforms, so as to avoid trouble about opening the doors at freight houses.

Standard Drip Cup for Refrigerators.

The committee has not yet been able to find any drip cup which will meet all of the requirements, which now seem impossible to meet in full, but the committee will continue to investigate the subject and make supplementary report.

Relatively Small Ice Tanks.

Refrigerator cars may be divided into two general classes—

(1) Fresh-meat cars.

(2) Fruit and dairy cars.

(1) The best and most modern refrigerators are used for shipping fresh meats, and these are provided with ice tanks which experience has proven to be amply large. Fresh-meat cars use crushed ice and salt, and a total capacity of 5,000 pounds per car has been found ample for all ordinary service conditions; the committee, therefore, recommends that tanks of 5,000 pounds ice capacity be adopted as the minimum for such cars.

(2) For fruit and dairy refrigerators a minimum of 3,000 pounds per tank, or 6,000 pounds per car, is recommended. Our investigation leads us to believe that the complaints mentioned by the Railroad Refrigerator Service Association have been caused by old cars that had ice tanks much smaller than the present practice, which are rapidly disappearing from service, and we believe tanks of the size above recommended are amply large to protect shipments under all ordinary conditions.

The Traffic Department will be the first to object to encroaching any further than necessary on the loading space of the car, and there seems to be no present necessity for increasing the outside length of the car beyond about 40 feet, the present size of the largest refrigerator.

Discussion.—A supplementary report was read by Mr. Barnum (I. C.) as follows:

The committee has continued its investigation of a standard drip cup for refrigerator cars, and has obtained from a number of the roads which are the largest owners of refrigerators and also from the packing companies drawings of their standard drain cups, together with reports on their performance. All of these drain cups are alike in their essential features, consisting in:

1. A depression or cup below the level of the drip pan into which the water drains; and

2. A drain pipe, the top of which projects above the bottom of the cup to a varying height, thereby retaining some water in the cup round about the pipe, which, with the inverted cap fitted over the top of the drain pipe, forms a water seat. This arrangement permits the melted ice to overflow into the drain pipe and at the same time prevents the admission of warm air in summer; but it will not obviate freezing in winter, and the drain pipe must be plugged to exclude cold air in freezing weather. All of the replies received to our inquiries indicate that there are no serious complaints about the last two features. Our investigation leads us to believe that the combination of requirements specified by the Railroad Refrigerator Service Association are mechanically impossible.

Mr. Barnum also explained that a change should be made in the report in connection with the height of freight house platforms, which it was proposed to have the Maintenance of Way Association make standard. These should be 44 in. instead of 46 in., as stated in the report, thus leaving a difference of 4 in. between the level of the car floor and top of platform.

Mr. Hennessey (C. M. & St. P.) asked for information concerning what was being done in connection with salt water drippings, which he found were still giving considerable trouble. It was explained that private car owners, who are the principal users of salted ice, were active on this subject, but had found difficulty in getting a valve to answer the purpose of holding the water within the tanks. It was found that this valve would freeze and give considerable difficulty in operating. The cars, however, were being fitted and experiments were continually being carried on with different arrangements and it was expected that success would eventually be attained.

The recommendations of the committee were ordered submitted to letter ballot.

PRICES FOR LABOR AND MATERIAL FOR STEEL CARS

Committee:—F. H. Clark, chairman; G. E. Carson, C. F. Thiele, Ira Everett, B. Julien, S. T. Park, T. M. Ramsdell.

The recommendations of the committee are as follows:

Eliminate all present rules on page 58 of the 1910 Code of Rules, with reference to repairs to steel cars, and substitute the following:

All rivets ½-inch diameter or over, 12 cents net per rivet, which covers removal and replacing of rivets, including removing, fitting, punching or drilling holes when applying patches or splicing and replacing damaged parts, not to include straightening.

All rivets ¼-inch diameter and less than ½-inch diameter, 7 cents net per rivet, which covers removal and replacing of rivets, including removing, fitting, punching or drilling holes when applying patches or splices and replacing damaged parts, not to include straightening.

Straightening or repairing parts removed from damaged car, 60 cents per 100 pounds.

Straightening or repairing parts in place on damaged car; also any part that requires straightening, repairing or renewing, not included on rivet basis, 24 cents per hour.

Paragraph showing steel-scrap credits to be eliminated from Rule No. 111, on page 58; also Rule No. 107, on page 51, to be eliminated, and charges and scrap credits shown in Rule No. 104, on page 51, change to read as follows:

	Charge.	Credit.
Steel, plate and structural, per pound....	.03	.00½
Steel, pressed and flanged, per pound.....	.04½	.00½

In making repairs to cars on a rivet basis, the cost of removing and replacing fixtures not secured by rivets, but necessarily removed in order to repair or renew adjacent defective parts,

should be in addition to the rivet basis; rules covering wood-car repairs to govern.

Paint applied, one-quarter hour labor to be allowed per pound of paint applied and on the basis of Rule No. 105.

The report was approved and the recommendations of the committee were referred to letter ballot.

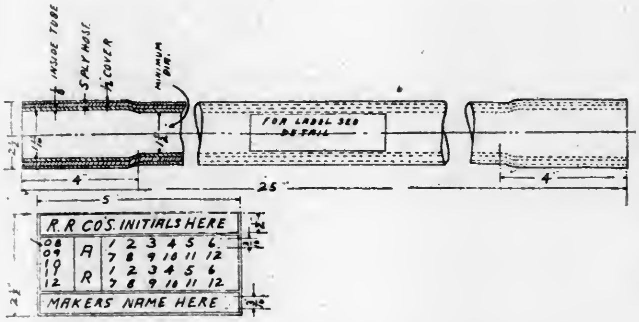
TRAIN PIPE AND CONNECTIONS FOR STEAM HEAT

Committee:—I. S. Downing, chairman; H. E. Passmore, T. H. Russum, J. J. Ewing, C. A. Schroyer.

In the report of the committee last year the committee recommended the following Recommended Practices be advanced as Standard:

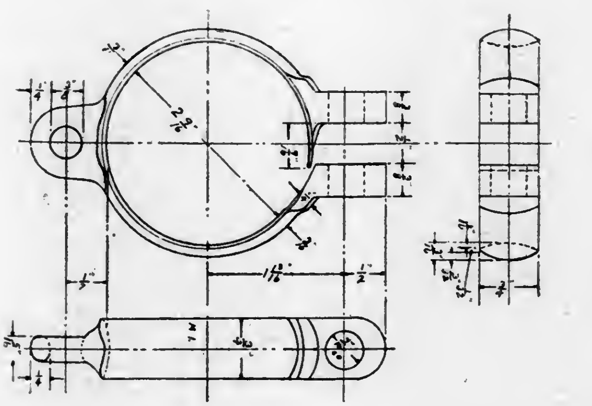
1. Two-inch train line.
2. Location of steam train line, signal and brake pipe, as shown on M. C. B. Sheet Q.
3. End train-pipe valves.
4. Length of steam hose from face of coupler gasket to end of nipple.

The above recommendations have been recommended prac-



tices since 1903, and in view of this the committee felt justified in recommending that they be advanced to standards. The committee will again recommend the 2-inch train line, end valves and location of pipes. The latter recommendation will be changed to show the dimensions taken from center line of car, instead of center line of coupler shank. The nipple recommended last year is again recommended, all dimensions being shown. The committee found but a slight difference in nipple furnished by the different manufacturers.

In regard to steam hose—the present recommended practice is 1⅝ inches diameter. The committee finds but few roads are using hose larger than 1½ inches, and there would not be any



great hardship in adopting 1½ inches inside diameter as recommended practice in place of 1⅝ inches.

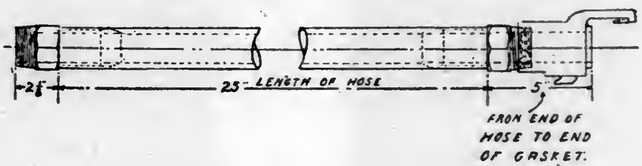
The committee do not feel that it can report on a coupler at this time.

The committee would recommend for adoption as standards the following:

1. Two-inch train line.
2. End valves, with not less than 1½-inch openings.
3. Location of steam, air and signal pipe, as shown on Print A (not reproduced).

The committee would recommend for adoption as recommended practice the following:

1. Nipple, as shown on Print B. (See American Engineer, August, 1910.)
2. Steam hose, five-ply, 1½ inches inside diameter, 25 inches long. Print D.
3. Hose clamp, as shown on Print E.
4. Each end of hose to be fitted with nipple, as shown on Print B.
5. Coupler to have not less than 1½-inch opening. The horizontal elevations of nipple to opening through coupler is, mini-



mum, 15 degrees; maximum, 20 degrees. Coupler to be tapped with 1½-inch pipe thread, as shown on Print F.

It is the further recommendation of the committee that the manufacturers of steam-hose couplers be asked to appoint a committee to act jointly with a committee of this association, to report at the next convention on the contour lines of a coupler that will make it interchangeable.

Discussion.—The matter of the length of the hose was considered, C. E. Fuller (U. P.) believing that a 25-in. hose was too long, and that it should not be over 24 in. F. W. Brazier (N. Y. C.) stated that on the long cars he had found it absolutely necessary to have a hose at least 25 in. in length. It was found that the hose after being in service for a time would become sometimes 1½ in. shorter than when applied. This was due to the congealing anad hardening of the hose, and was found to occur in the yards as well as on trains.

T. H. Curtis (L. & N.) reported that he had used 26 in. hose on passenger equipment, but had found it too long, and was now using 24 in. hose.

The angle of the head to prevent kinking of the hose was discussed, Mr. Fuller stating that in the majority of cases the present head would make a kink in the hose and that he would like to see the committee continued and make further report on this particular point. He further stated that he would like to see this committee charged with the recommending of standard equipment throughout, including size of hose, and other features. A motion to this effect was finally carried.

There arose considerable objection to the use of a two-piece coupling with a separate nipple, and it was explained that the committee simply recommended this as a makeshift until a standard could be arrived at.

The report was finally accepted and submitted to letter ballot.

CAR WHEELS

Committee:—Wm. Garstang, Chairman; A. E. Manchester, O. C. Cromwell, W. C. A. Henry, R. W. Burnett, J. A. Pilcher, R. L. Ettenger.

A point brought out by the Manufacturers' Association is, that under present conditions with high-braking pressures, the limiting factor for each weight of wheel is the temperature stresses set up on account of the rapidity with which heat is generated on the surface of tread of the wheel under heavy and continuous braking.

As the present tendency is toward increased braking pressure, it is thought possible that the present weights should be raised, particularly for wheels used under cars of high tare weight, such as refrigerator cars of 60,000 pounds marked capacity, for which at present the standard 625-pound wheel is used.

As this question was found to be quite far-reaching in its effect upon the present standards, and sufficient time was not available to give it the thorough investigation that it demands, the committee does not feel justified in making a recommendation at this time.

It is considered of such importance, however, that your attenton is called to same here in order that a study be made of the subject.

The committee, also, has been called upon to take up as additional work, its recommendations in the 1910 report, bearing on diameters of steel and steel-tired wheels in connection with coupler heights, efficiency of brakes, with respect to angularity of hangers and clearances necessary to provide adjustments. Its deductions from replies made to circular of inquiry on these points are given below.

To this circular we received twenty-nine replies. After a careful analysis of the replies, it was found that the maximum diameter of steel or steel-tired wheels that can be used by most of the railroads and keep a draw-bar height not to exceed 34½ inches and be used in connection with the existing brake beams and head was 33 inches, several of the roads reported that they could use 33½ inches and in a few instances 34 inches and 34½ inches.

In deciding upon the minimum diameter to which all-steel or steel-tired wheels should be worn, the question of maintaining a draw-bar height of not less than 31½ inches—making allowances for compression of springs, wear of journal and brasses, and also to compensate for the wear of the wheels—was duly considered. Three methods were suggested that can be used, depending upon the construction of the trucks, as follow:

1. Lining under center plate and side bearings.
2. Blocking under spring seat.
3. Lining on top of journal box.

The first-mentioned method can only be used to a limited extent where detachable center plates and side bearings are used.

The second method can be adopted in cases where the clearance between the top of the bolster and truck frame is sufficient to allow for wear of journals and bearings and for necessary reduction in the diameter of the wheels. On trucks with steel side frames, this cannot be done in many instances, and attention is called to this in order that greater clearance between the top of bolster and the truck frame be allowed in new construction.

The third method can be used in most trucks except such as have the boxes cast solid with the frames, and consists in using two or three thicknesses of metal liners applied between the tie bars and the bottom of the journal box, when using maximum diameter of wheel. These liners to be transferred one by one to the top of the box as the diameter of the wheel decreases.

With either of these methods it is possible in many cases to use a minimum wheel diameter of 30 inches. The majority of the roads, however, advise that the minimum diameter that can be used under present equipment is 32 inches.

From the replies that were received to the circular of inquiry, the following table was compiled, showing the number of railroads, the number of 40 and 50 ton cars operated by same, and the minimum diameter to which wheel could be worn on these roads:

TABLE SHOWING NUMBER OF RAILROADS AND CARS OWNED BY SAME RAILROADS AND THEIR RECOMMENDATIONS FOR MINIMUM DIAMETER FOR ALL-STEEL OR STEEL-TIRED WHEELS.

9 roads representing	151,611,	40 & 50 ton cars,	recommend	32 -in. wheels
3 roads representing	42,582,	40 & 50 ton cars,	recommend	31½-in. wheels
1 road representing	12,186,	40 & 50 ton cars,	recommends	31¼-in. wheels
2 roads representing	49,117,	40 & 50 ton cars,	recommend	31 -in. wheels
1 road representing	101,	40 & 50 ton cars,	recommends	30½-in. wheels
2 roads representing	120,619,	40 & 50 ton cars,	recommend	30 -in. wheels
1 road representing	1,492,	40 & 50 ton cars,	recommends	29¾-in. wheels
1 road representing	24,531,	40 & 50 ton cars,	recommends	29½-in. wheels

From these results the committee does not feel disposed to recommend a specific dimension as a minimum diameter at which all-steel or steel-tired wheels should be worn before replacement.

On account of the great variation in diameters due to wear that might be possible with the use of all-steel and steel-tired wheels, and the effect that this wear will have on the efficiency of the brakes due to the increased angularity of the brake hangers and levers, the committee has forwarded to the Committee on Train Brakes, all data bearing on this subject for its consideration.

RECOMMENDATIONS.

GAUGES AND LIMITS.

First. At present, three standard gauges are shown on Sheet No. 16 Standard Practice, M. C. B. Proceedings, 1910, one for mounting, one for inspecting and one for checking wheels.

As these gauges are all slightly dfferent, they are confusing to the shopmen, and it has been proposed that one gauge be used in place of the three gauges now shown. This method has been found to be entirely practical, and is, in fact, followed by many roads.

The present wheel-check gauge, shown on Sheet No. 16, M. C. B. Standard, fulfils the requirements of such a gauge, and it is recommended that a cut of this, as shown on the attached drawing, be substituted for the three gauges now shown on Sheet No. 16 of the M. C. B. Standard Practice.

In order to better protect the gauge from wear, the gauging point at the throat of the wheel has been increased from ⅛-inch to ¼-inch. This has the further advantage of more nearly approximating the original location in remounting second-hand wheels.

It is also recommended that the first sentence, paragraph 3, under Mounting Wheels in Recommended Practice, be changed as follows:

"Third.—That in mounting wheels new or second-hand, the standard wheel-mounting and check gauge' be used in the following manner:"

Second. In 1909 the Railway Club of Pittsburgh made the following suggestion:

"The dimension 4 feet 5 3/32 inches on Figure 6-A, be changed to 4 feet 5 5/32 inches, due to not mounting more than one wheel with maximum flange thickness on the same axle. In accordance with Rule 66."

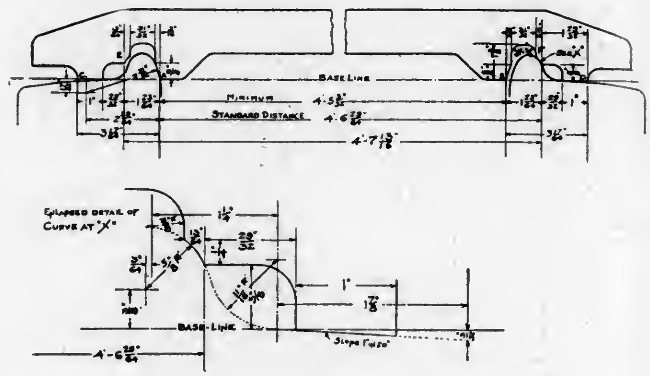
This was approved by the Arbitration Committee in 1909 and changes made in the Code of Rules. The gauges shown on Sheet 16, however, were not changed. The dimension referred to is the distance between backs of flangs at the base line.

After careful consideration, the committee does not feel that this dimension should have been increased to 4 feet 5 5/32 inches, as it will not accomplish the purpose for which this change was intended, or to prohibit the mounting of two maximum flanges on the same axle.

It is, therefore, recommended that this dimension should be 4 feet 5 3/32 inches as recommended in 1907 report. This will necessitate changing the dimension 4 feet 5 5/32 inches on Figure 9, page 37, Code of Rules, and Figure 9, page 599 of the proceedings of 1910, back to 4 feet 5 3/32 inches.

Third. The second paragraph of Rule 24 in Code of Rules reads:

"In no case may two new wheels having maximum thick flanges be mounted on the same axle." It is recommended that



the wording of this rule be changed to the following: In no case should two new wheels be mounted on the same axle when the thickness of the two flanges together will exceed the thickness of one normal and one maximum flange, or 2 17/32 inches.

Fourth. The committee recommends that the standard wheel circumference gauge be changed as follows:

That the number of brackets be increased from 3 to 4 and the length of the brackets increased toward the rim of the wheels so as to project ⅛-inch beyond the rim when the brackets are in proper position.

Fifth. The present method of graduating the circumference measure does not provide a definite boundary for each tape size as the tape sizes are indicated with lines.

It is, therefore, recommended that instead of defining a tape size with a line, it be defined by the spaces.

Sixth. The committee recommends that the limit-gauge for remounting second-hand cast-iron wheels, which is shown on Sheet 16-A of the Proceedings of 1910 of the M. C. B. Association, be shown in the different positions in which it is to be used with explanatory notes.

Seventh. It is recommended that the minimum flange thickness gauge for new wheels, shown on Sheet 16 of the 1910 Proceedings of the M. C. B. Association, have the figure 1 5/32 inches changed to 1 11/64 inches in order that the minimum thickness of flange be as much below, as the maximum thickness of flange is above, a normal flange.

Eighth. The Association of Manufacturers of Chilled Car Wheels has suggested that a few changes be made in the design of the present standard wheels in order to improve foundry practice and reduce losses.

625-POUND WHEEL.

A slight reinforcement in the outside rim by moving the radius 1 5/16 inches, 1/16-inch toward center of wheel, the object of which is to improve foundry condition in drawing the pattern from the sand.

Also the fillet in the acute angle of bracket and tread to be increased to ⅜-inch, this in order to allow the pattern to be drawn from the mold without breaking down the sand.

675-POUND WHEEL.

A slight reinforcement in the outside rim by moving the radius 1 3/16 inches, 1/16-inch toward the center of the wheel.

The fillet in the acute angle of bracket and tread to be increased to ⅜-inch, this in order to allow the pattern to be drawn from the mold without breaking down the sand.

Also, change the radius of the intersection of front plate from 2 inches to 3 inches to correspond with the 625-pound wheel; this will improve the metal at intersection and reduce the skimming action at this point while the metal is flowing from the hub to the rim.

The top contour of the bracket to be reinforced at its junction with a flange as shown on drawing.

725-POUND WHEEL.

Make a slight reinforcement in the outside rim by moving the radius 1⅛ inches, ⅛-inch toward the center of the wheel.

Also the fillet in the acute angle of bracket and tread to be increased to ⅜-inch, in order to allow the pattern to be drawn from the mold without breaking down the sand.

Change the radius of the intersection of front plate from 2 inches to 3 inches to correspond with the 625-pound wheel. This will improve the metal at intersection by reducing the skimming action at this point while the metal is flowing from the hub to the rim.

The top contour of the bracket to be reinforced at its junction with the flange as shown on drawing (not reproduced).

Increase the thickness of the brackets at the base from 1 5/16 inches to 1⅜ inches.

Tenth. It is also recommended that the part of the paragraph No. 8, page 763, of the Proceedings of the Association of 1910, which reads as follows:

"And the day, month and year when made, plainly formed on the inside plate in casting."

Be changed to read:

And the month, day and year when made, plainly formed on the inside plate in casting.

STEEL AND STEEL-TIRED WHEELS FOR FREIGHT SERVICE.

Eleventh. It is recommended that the diameter for all new steel and steel-tired wheels for freght cars be made 33 inches.

Twelfth. For high-capacity freight cars built in the future and likely to be equipped with steel wheels, it is recommended that provisions be made in the construction of car and trucks to permit the use of wheels varying in diameter from 33 inches to 30 inches.

Discussion.—Considerable discussion was given to the subject of recommendations of the committee for standard 33 in. diameter. It was pointed out that in the case of the steel tired wheel it was possible to turn the diameter to 30 in., which would affect not only the brake beams and hangers, but the height of the draw bar and other details. The discussion brought out the fact, however, that fully 90 per cent. of the answers to a circular specified a 33 in. wheel. No action was taken at the meeting to change the recommendations of the committee, the report of which was accepted and submitted to letter ballot.

It was moved by C. E. Fuller (U. P.) that the subject of fastenings for built up wheels be considered in next year's report. Mr. Garstang suggested the preparing of drawings showing the principal dimensions of steel and steel tired freight wheels.

SPRINGS FOR CAR TRUCKS

The secretary reported that this committee had not succeeded in getting together sufficient information to cover the subject properly and that it requested more time.

LUMBBR SPECIFICATIONS

No report from this committee was received, and the work of the previous year being so satisfactory and covering the subject so well, the committee was discharged.

CONSOLIDATION

In a verbal report, F. H. Clark (B. & O.), chairman of the committee, stated that the work assigned to the committee this year was to investigate the question of legality of the proposed consolidation. They had done so and had found that there was no legal objection to the consolidation of the two associations.

It was moved by Mr. Seley that the report of the committee be received and that the committee be continued.

In discussing this motion G. W. Wildin (N. Y., N. H. & H.) urged action of some sort on this question and suggested that the committee be instructed to prepare a plan for consolidation at the next convention. A motion to this effect, however, was lost.

20th CENTURY AUTOMATIC LOOSE PULLEY OIL CUP

The accompanying cuts illustrate the manner in which the principle of centrifugal force is used to automatically oil loose pulleys. This cup, which is manufactured and sold by the American Specialty Co., of Chicago, Ill., is made of thin pressed steel, and is so light that counterbalancing is not necessary. It will run from one to three weeks per filling, according to the number of starts and stops, speed, etc. All oil put into the cup goes to the bearing and the nuisance of having oil flung and spattered over floor, workman, machines and belts is entirely eliminated, and with it a decided saving in oil and time is effected.

Fig. 1 shows the cup ready to screw into the hub of the wheel. Fig. 2 is a view of the inside, showing the feeding

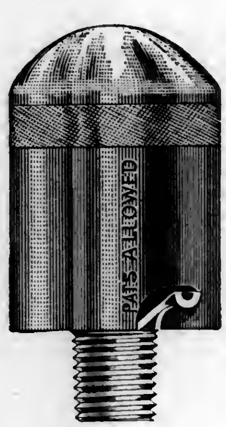


FIG. 1.

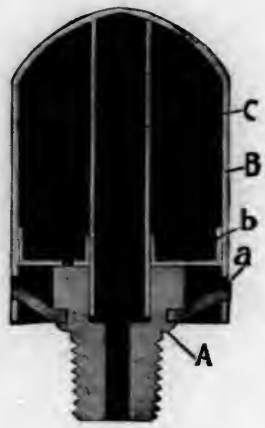


FIG. 2.

tube. When the pulley is brought into operation the centrifugal force throws the oil to the top of the cup and fills the feeding tube. When the pulley starts next time a portion of he oil in the tube is fed to the bearing, and the tube again fills itself. Fig. 3 shows the cup detached from the nipple for filling. This can be done easily by hand, no wrenches being required. The

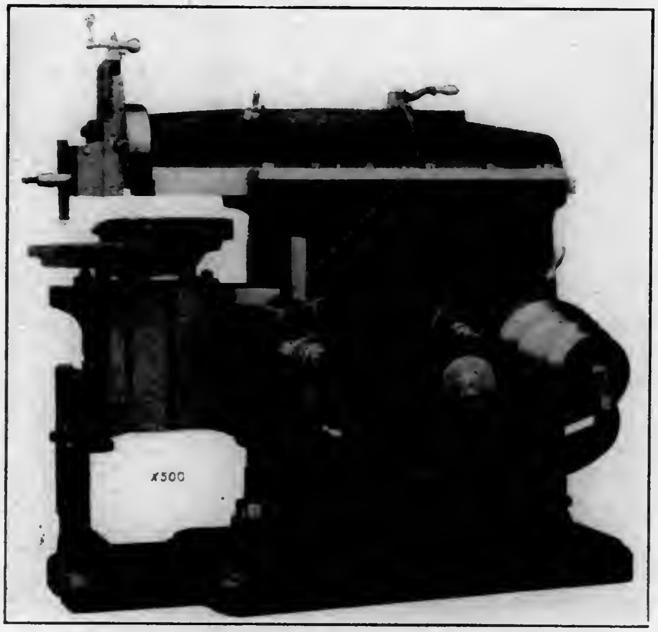
FIG. 3.

cup can be removed, filled and replaced with the pulley in any position, thus doing away with the necessity of shifting belts, turning shafting, etc., to bring the oil hole on top.

THE PLYM FELLOWSHIP COMMITTEE of the University of Illinois announced the choice of Donald Graham of the Class of 1907 as the winner in competition for the fellowship for the year 1911-12. The fellowship as established by Francis J. Plym yields $1,000, and it is conferred for the purpose of assisting graduates of exceptional promise of the Department of Architecture of the University of Illinois to a year of foreign travel and study.

THE NEW DESIGN "QUEEN CITY" BACK GEARED CRANK SHAPER

Just eight years ago, soon after the introduction of high speed tool steels, the Queen City Machine Tool Co., of Cincinnati, O., was organized to manufacture back-geared crank shapers. The first 16-in. machine was described in this journal in the fall of 1903. Since then these shapers have fully kept pace with the improvements in tool steels, and now they are capable of using the very best to their highest capacity for double duty and speed. The accompanying illustration represents the 16-inch back-geared shaper of to-day, and the improvements in same will be incorporated in the three larger sizes during the present year. It is with these changes that this description has most to do. Part of them have been an evolution of the past eight years, but the most important—the improvement in the radial bearings—is just being used on this machine, the Queen City people being pioneers on this construction in shaper manufacture.



POWERFUL AND ACCURATE 16-INCH SHAPER.

It is of course appreciated by the users of machine tools, and by those familiar with their construction, that the greatest trouble experienced is due to poor lubrication and inadequate bearings. In the crank shaper, the bearings that have to do with delivering the driving power to the ram, in the order of their importance, are as follows: crank pin, bull wheel, driving and driven shafts, and the lower rocker arm shaft and those that connect the link with rocker arm and ram. These all have heat treated and ground journals running in cast iron. The crank pin has the heaviest duty to perform in proportion to its size: the body of this is made from a crucible steel casting, and has a heat treated sleeve pressed over the pin, and is ground to be a running fit in the cast iron crank block; this block has an oil reservoir with channels cut to insure thorough distribution of the oil, which is lifted from the reservoir onto the crank pin by a chain, the oil always flowing back to the reservoir; thus, a continual flow of oil is sure to result if proper attention is paid to providing a supply of good oil, as means have been provided for drawing off the oil when used up and replacing it with a fresh supply.

The bull wheel hub also has a hardened sleeve pressed on it, and is afterwards ground to size; the same oiling device is used here as on the crank pin just described. The cone pulley shaft has a 3-point bearing eliminating the overhang at drive. The five journals of the driving and driven shafts are heat treated and ground, run in removable cast iron bushes, and are kept flooded with oil by means of ring oilers. The chain is used on crank pin and bull wheel hub, and other bearings in the feed that revolve, because a ring will not lift sufficient oil when shaper is running at slow speeds. The rocker arm and link shafts are provided with good lubricating facilities, although neither ring or chain can be used, because the motion is not fully rotary, only about one-quarter of a circle being described.

The best test of a shaper is to note the proportion of the power delivered to what is available at the cutting tool. The belt pull of this shaper is below the average, yet it will take very heavy cuts; the countershaft should run at 270 r. p. m. The four cone steps are 6 in., 7 9/16 in., 9⅛ in., 10 11/16 in. for a 2-in. double belt. Single gear ratio, 4 to 1; back gear ratio, 19 to 1. This combination will figure to the following cutting strokes to ram· 7.98, 11.78, 17.15, 25.31, 37.9, 55.95, 81.45 and 120.24 per minute, which it will be noted are in geometrical progression. There are twelve changes of feed instantly obtainable without danger to the operator's fingers. These eight speeds and twelve feeds can be so combined as to cover every requirement for the turning out of work rapidly. Roughing can be done much faster with a slow speed and wide feed, and with less shock to the machine than excessive high speeds.

Something of the workmanship and rigidity of this shaper can be judged by the guaranteed accuracy; the makers agree to produce work to within .0005 in. for the full 16-inch stroke, and vise is square to this limit. The arch ram is a big factor in securing the rigidity of the cutting tool necessary to produce this accuracy, while the design and position of the table support and rigid construction of column, rail, etc., enables the work to be solidly held while being machined; the least movement of the work has a tendency to cause the tool to gouge when taking heavy cuts; this table support is closely gibbed to table, eliminating both the up and down movement of the work; the base has an extra solid footing as it is made very long to bring table support out to extreme end of table.

This shaper is also very low, making it handy for the operator, whose every movement is considered at each point. The long and low design also provides for long ram bearings in the column, and it will be noted that the ram is very long in proportion; also, less metal is required to produce a rigid and substantial machine. All flat bearing surfaces are of large area, and gibbed for taking up the wear. The feed screws have micrometer adjustments, and the swivels are graduated. All pinions are made from bar steel, and where considered necessary parts are of steel and heat treated where service requires it to insure long life. All gear teeth are generated, and all gears and T slots cut from the solid. Shafts of any length may be key seated under the ram.

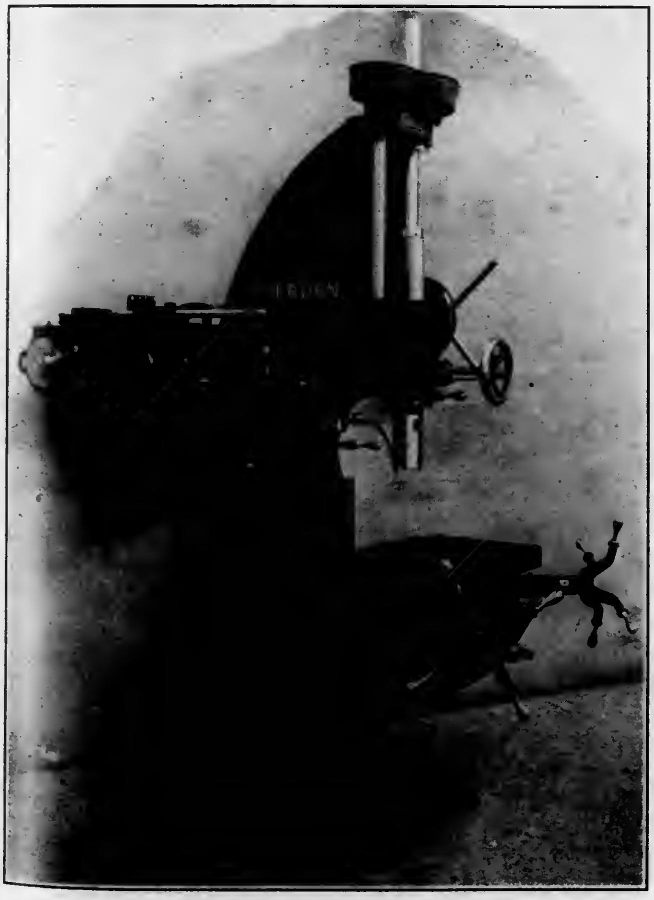
IMPROVED HEAVY DUTY DRILL PRESS

The Colburn Machine Tool Co. have lately made some important improvements in their line of heavy duty drill presses, and the illustration shows the D-3 size machine, which has a capacity for drilling three-inch holes with high speed drills in solid steel at the feeds and speeds recommended by the drill manufacturers. The following are some of the more important improvements embodied in their latest design. The first machines had a right angle drive, that is, the main driving shaft stood at an angle of 90 degrees to the line shaft, necessitating the use of the quarter turn belts when a number of machines were set in a row and driven from one line shaft. This is now changed, so that the main driving shaft in the speed box, on which is mounted the driving pulley, sets parallel to the line shaft. This allows any number of machines to be set in a row side by side and belted with straight belt direct from one line shaft.

The speed box is an entirely new design. It is mounted upon a substantial extension or knee at the rear of the main column.

There are eight changes of speed obtained through sliding gears and positive clutches. All speed changes are made with two levers which are within easy reach of the operator while standing in front of the machine. Four speed changes are made similar to the changes with a selective transmission on an automobile. All the gears in the speed box are made of steel and the corners of the teeth beveled where they slide together. Gears subjected to the heaviest strain are hardened. All bearings have bronze bushings. The speed box is so designed that it forms a perfectly tight, non-leakable oil reservoir and everything inside receives a continuous bath of oil. This feature greatly adds to the life of the gears and bearings besides practically eliminating noise. A target, on top of the speed box in plain sight of the operator, shows which gears are engaged. A set of back gears increases the speeds to eight and these are engaged and disengaged by means of a lever, plainly shown in the illustration.

The machine is driven through a friction clutch pulley operated by means of a lever. This being a high speed drill press, the gears run at a high rate of speed and it is impossible to make the speed changes when driven by the regular clutch pulley on account of the severe impact caused by too sudden engagement of the gears and clutches. To overcome this, an auxiliary friction clutch is interposed between the main friction pulley and the gears in the speed box. By its use the gears are made to turn very slowly, and the different speed changes can be made without the slightest jar or shock. The different speeds and feeds and the combination by which they are obtained are



COLBURN, SIZE D-3, HEAVY DUTY DRILL PRESS

shown on a speed and feed index plate attached to the feed box in plain sight, and the operation of changing either speeds or feeds is most simple.

The feeds, of which there are six, are obtained by means of the pull rod operating the back gears and the pull rod operating the drive key. To change the feeds on the high speeds it is advisable to stop the machine and proceed as for changing speeds, but when running on the slow speeds the machine need not be stopped to change the feeds. The whole operation of speed and feed changing is extremely simple and is very quickly made. By looking at the index plate the operator can see at a glance just what to do to get any desired feed or speed or he can tell at just what feed or speed the machine is running, by noting the positions of the levers and rods and comparing them with the index plate. It will be seen that all the working levers are so placed that the operator, while standing in front of the machine, can reach any of them without stooping over. This feature saves many minutes in a day's work and is an important factor in increasing production. In addition to the graduated dial automatic feed tripping device another safety trip is added which automatically trips the feed when the spindle has reached its lowest position. This prevents possible accident on account of feeding down too far.

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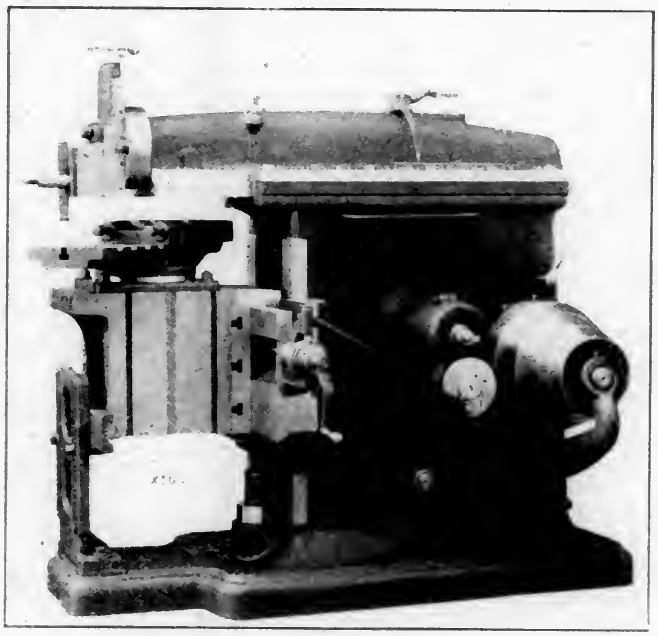
POSITION WANTED

THE NEW DESIGN "QUEEN CITY" BACK GEARED CRANK SHAPER

Just eight years ago, soon after the introduction of high speed tool steels, the Queen City Machine Tool Co., of Cincinnati, O., was organized to manufacture back-geared crank shapers. The first 16-in. machine was described in this journal in the fall of 1903. Since then these shapers have fully kept pace with the improvements in tool steels, and now they are capable of using the very best to their highest capacity for double duty and speed. The accompanying illustration represents the 16-inch back-geared shaper of to-day, and the improvements in same will be incorporated in the three larger sizes during the



POWERFUL AND ACCURATE 16-INCH SHAPER.

present year. It is with these changes that this description has most to do. Part of them have been an evolution of the past eight years, but the most important—the improvement in the radial bearings—is just being used on this machine, the Queen City people being pioneers on this construction in shaper manufacture.

It is of course appreciated by the users of machine tools, and by those familiar with their construction, that the greatest trouble experienced is due to poor lubrication and inadequate bearings. In the crank shaper, the bearings that have to do with delivering the driving power to the ram, in the order of their importance, are as follows: crank pin, bull wheel, driving and driven shafts, and the lower rocker arm shaft and those that connect the link with rocker arm and ram. These all have heat treated and ground journals running in cast iron. The crank pin has the heaviest duty to perform in proportion to its size, the body of this is made from a crucible steel casting, and has a heat treated sleeve pressed over the pin, and is ground to be a running fit in the cast iron crank block; this block has an oil reservoir with channels cut to insure thorough distribution of the oil, which is lifted from the reservoir onto the crank pin by a chain, the oil always flowing back to the reservoir, thus, a continual flow of oil is sure to result if proper attention is paid to providing a supply of good oil, as means have been provided for drawing off the oil when used up and replacing it with a fresh supply.

The bull wheel hub also has a hardened sleeve pressed on it, and is afterwards ground to size; the same oiling device is used here as on the crank pin just described. The cone pulley shaft has a 3-point bearing eliminating the overhang at drive. The five journals of the driving and driven shafts are heat treated and ground, run in removable cast iron bushes, and are kept flooded with oil by means of ring oilers. The chain is used on crank pin and bull wheel hub, and other bearings in the feed that revolve, because a ring will not lift sufficient oil when shaper is running at slow speeds. The rocker arm and link shafts are provided with good lubricating facilities, although neither ring or chain can be used, because the motion is not fully rotary, only about one-quarter of a circle being described.

The best test of a shaper is to note the proportion of the power delivered to what is available at the cutting tool. The belt pull of this shaper is below the average, yet it will take very heavy cuts; the countershaft should run at 270 r. p. m. The four cone steps are 6 in., 7 9/16 in., 9⅛ in., 10 11/16 in. for a 2-in. double belt. Single gear ratio, 4 to 1; back gear ratio, 19 to 1. This combination will figure to the following cutting strokes to ram: 7.98, 11.78, 17.15, 25.31, 37.9, 55.95, 81.45 and 120.24 per minute, which it will be noted are in geometrical progression. There are twelve changes of feed instantly obtainable without danger to the operator's fingers. These eight speeds and twelve feeds can be so combined as to cover every requirement for the turning out of work rapidly. Roughing can be done much faster with a slow speed and wide feed, and with less shock to the machine than excessive high speeds.

Something of the workmanship and rigidity of this shaper can be judged by the guaranteed accuracy; the makers agree to produce work to within .0005 in. for the full 16-inch stroke and vise is square to this limit. The arch ram is a big factor in securing the rigidity of the cutting tool necessary to produce this accuracy, while the design and position of the table support and rigid construction of column, rail, etc., enables the work to be solidly held while being machined; the least movement of the work has a tendency to cause the tool to gouge when taking heavy cuts; this table support is closely gibbed to table, eliminating both the up and down movement of the work; the base has an extra solid footing as it is made very long to bring table support out to extreme end of table.

This shaper is also very low, making it handy for the operator, whose every movement is considered at each point. The long and low design also provides for long ram bearings in the column, and it will be noted that the ram is very long in proportion; also, less metal is required to produce a rigid and substantial machine. All flat bearing surfaces are of large area, and gibbed for taking up the wear. The feed screws have micrometer adjustments, and the swivels are graduated. All pinions are made from bar steel, and where considered necessary parts are of steel and heat treated where service requires it to insure long life. All gear teeth are generated, and all gears and T slots cut from the solid. Shafts of any length may be key seated under the ram.

IMPROVED HEAVY DUTY DRILL PRESS

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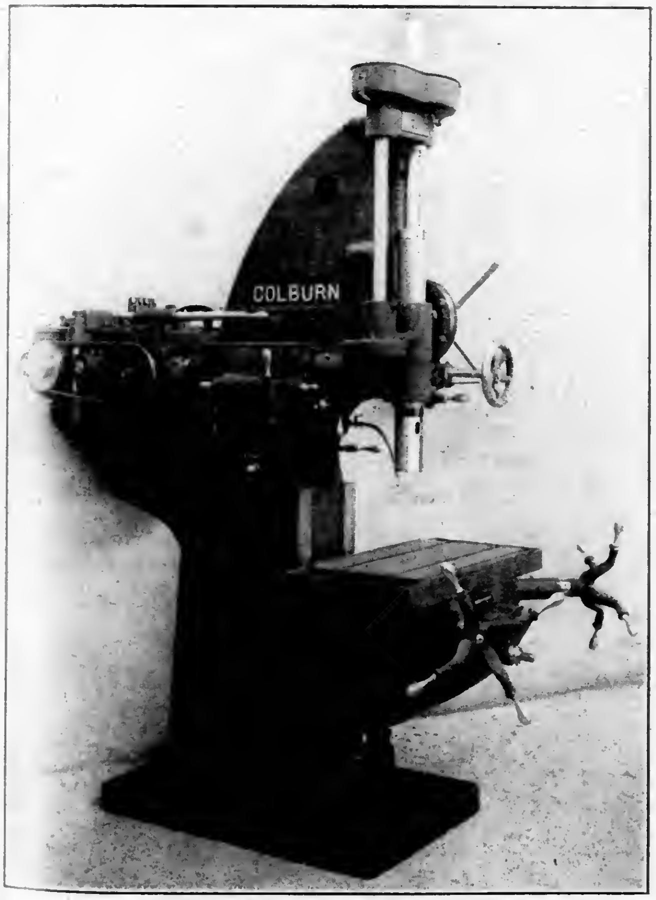

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PERSONALS

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E. R. Lockhart has been made master mechanic of the Missouri Pacific Ry. at Hoisington, Kans.

W. W. Morrow has been made general foreman of the Santa Fe at Prescott, Ariz., vice C. F. Ryer, resigned.

E. W. Cantwell has been made master boilermaker of the Big Four at Bellefontaine, O., vice J. R. Cushing, deceased.

F. M. Kerwin has been made roundhouse foreman of the Chicago, Rock Island & Pacific Ry. at Silvis, Ill., vice T. Kilpatrick, promoted.

W. H. Sample has been appointed master mechanic of the Grand Trunk Ry., at Ottawa, Ont., vice R. Cowan, assigned to other duties.

E. H. Bankard, purchasing agent of the Baltimore & Ohio R. R., has had his jurisdiction extended over the Cincinnati, Hamilton & Dayton Ry.

R. H. Collins has been appointed inspector of roundhouse and shop efficiency of the St. Louis & San Francisco R. R., with office at Springfield, Mo.

Millard F. Cox has been appointed mechanical engineer of the Louisville & Nashville, R. R., with office at Louisville, Ky., succeeding W. A. Stearns, resigned.

H. A. Fabian, manager of purchases and supplies of the Maine Central R. R., at Boston, Mass., has had his jurisdiction extended over the Portland Terminal Company, with office at Portland, Me.

J. W. Blakeburn, road foreman of engines of the St. Louis Southwestern Ry., at Pine Bluff, Ark., has been appointed master mechanic, with office at Pine Bluff, succeeding E. English, resigned.

G. W. Deats, general foreman of shops of the Texas & Pacific R. R. at Fort Worth, Tex., has been appointed master mechanic of that road and the International & Great Northern R. R., with office at Fort Worth, a new position.

J. D. Maupin, master mechanic of the Trinity & Brazas Valley R. R., has been apointed superintendent of motive power, with office at Teague, Tex., vice C. H. Seabrook, resigned. The position of master mechanic has been abolished.

J. W. Small, superintendent of machinery of the Kansas City Southern R. R., at Pittsburg, Kan., has been appointed superintendent of machinery of the Missouri Pacific Ry., with office at St. Louis, Mo., succeeding G. W. Smith, resigned.

M. S. Curley, formerly master mechanic of the Frisco Lines at De Quincy, La., and formerly master mechanic of the Illinois Central R. R., at Paducah, has taken service with the O'Malley Bear Valve Co., Chicago, with office in Rand Building, Memphis, Tenn.

John P. Sykes, assistant general superintendent of the Baldwin Locomotive Works, Philadelphia, Pa., has been made general superintendent of the company, succeeding S. M. Vauclain, who held that position for the past 26 years, and who has now become vice-president.

P. M. Hammett, superintendent of motive power of the Maine Central R. R., has had his jurisdiction extended over the Portland Terminal Company, with office at Portland, Me. The jurisdiction of A. R. Manderson, assistant superintendent of motive power, is similarly extended.

M. J. McGraw has been appointed shop superintendent of the Missouri Pacific Ry. at Sedalia, Mo. The following additional shop superintendents are also announced: W. C. Smith, Kansas City; E. F. Stroch, Hoisington, Kans.; B. J. Peasley, De Soto, Mo., and B. E. Stevens, Argenta, Ark.

CATALOGS

Steel Tires.—The Standard Steel Works Company, Philadelphia, Pa., has issued a new catalogue on steel tires, giving in detail the specifications which were adopted by the American Society for Testing Materials. Illustrations, diagrams and a facsimile of dimension blank for orders are included.

High Tension Magnetos.—The Bosch Magneto Company, of New York, N. Y., has issued catalogs descriptive of its type "D. A. V." magneto for small and even cylinder "V" motors, and of the type "D. A. Q." for small single cylinder motors. These books are complete in every detail, with full information regarding the construction of the magnetos, and particularly so as regards the location of faults and directions for care and maintenance.

Electric Locomotives.—Bulletin No. 4851, just issued by the General Electric Company, is an attractive publication, containing data relative to the use of electricity in the service of steam roads. The publication comprises 48 pages, which illustrate and describe both station and road equipment of the New York Central and Hudson River Railroad; the Detroit Tunnel of the Michigan Central Road; the Cascade Tunnel of the Great Northern Railway; the equipment of the Baltimore & Ohio Railway; the West Jersey and Seashore, the West Shore Railroad, etc.

Flexible Staybolts.—Under the title, "The Breakage of Staybolts," the Flannery Bolt Company, of Pittsburgh, Pa., has recently issued a most attractive and interesting publication. While intended primarily, no doubt, to advertise the merits of the Tate flexible staybolt, the book in reality is a treatise on the subject which its title implies. In addition to other valuable features it contains an analytic discussion on expansion of locomotive boilers, and a theoretical discussion on the breakage of staybolts. The book is well illustrated and carries the impress of the greatest care in the selection and presentation of the text. It will be of great assistance to thoses who are called upon to combat the vexatious problem with which it deals.

Furnace Slag in Concrete.—Under this title the Carnegie Steel Co. has published an interesting illustrated booklet, the object of which is to present to those interested the results of a series of tests of blast furnace slag, in various forms for use as an aggregate in the making of concrete. A study of the pages of the booklet will show that the aggregate performs a very important function, and that the strength of the concrete depends largely on the shape, character and strength of the aggregate. Any material which will improve the quality of the concrete without materially adding to its cost, must command the attention of the user, and it is believed that these results of some preliminary tests on blast furnace slag used in concrete will be of great value to the concrete engineer.

Articulated Compound Locomotives.—Bulletin 1009, just issued by the American Locomotive Company, contains an interesting illustrated description of the 230-ton articulated compound locomotives recently delivered by that firm to the Baltimore and Ohio Railroad. Ten locomotives were included in this order, and the design is at least 40 per cent. heavier and more powerful than the pioneer articulated compound which was placed in service in 1904. The statement is made that twenty-nine of the leading railroads of the country are now using an aggregate of over 400 articulated locomotives. Nineteen of these have adopted this type within the past three years—four years or more since it was first introduced—which goes to prove that it has won favor through its known value from an operating standpoint.

NOTES

Bullard Machine Tool Co.—Announcement is made by this company that arrangements have been made with Harry Ellis, Jr., 1138 Mutual Bldg., Richmond, Va., for direct representation in the territory surrounding Richmond, and extending to the West Virginia line.

General Electric Co.—The Terre Haute, Indianapolis and Eastern Traction Company has placed an order with the General Electric Company for two 300-kw. rotary converters, fifteen 100-kva. transformers and a switchboard. The rotary converters and six of the transformers will be installed in the Maywood sub-station. Six of the transformers will be installed in the Mooresville sub-station, and three in the Martinsville substation.

Roberts & Schaefer Co.—The Roberts & Schaefer Co., engineers and contractors, Chicago, Ill., have recently secured a contract from the Oregon-Washington R. R. & Navigation Co. for the designing and building, complete in operation, of two Holmen locomotive coaling stations. One plant is to be installed at the Argo roundhouse at Seattle and is to be of 500 tons capacity with sand equipment. The other plant is to be installed at the new roundhouse at Tacoma, and is to be of 100 tons capacity. Approximate contract price for the above plants is $30,000.

Sprague Electric Works.—Frank W. Hall, manager of the Philadelphia office of the Sprague Electric Works, has been appointed manager of hoist sales and after July 15, 1911, will be located at the New York office. James A. Clifford, manager of the Baltimore office of the company, has been appointed manager of the Philadelphia office, and took charge there on July 1, 1911. The Baltimore office will be continued as in the past under Mr. Clifford's direction, but as subsidiary to the Philadelphia office and with Henry S. Patterson in charge.

Davis Bournonville Co.—Announcement is made that the business of this company will be divided into the Eastern Department, with offices in its present quarters, 90 West street, New York City, and the Western Department, with offices at 515 Laflin street, Chicago, the present quarters of the Chicago Welding Department of the National Pneumatic Company. It is believed that this consolidation will very materially assist the development of the welding and cutting industry, and the combined resources and experience of these companies will be at the service of all prospective users of autogenous apparatus.

nearly as possible, along the center line of the parts. The center plate proper is bolted to the center plate backing casting, and between the two a pocket is provided for use of centering springs, allowing side motion of one inch between center line of car body and center line of truck; the function of the springs being to form a cushion against side strains and to provide comfort in riding.

Each truck has one motor axle and one trailer axle, and the bolster is placed 2 inches out of center for the purpose of providing the same weight between wheel and rail for all the wheels on the truck. The side frames are of "H" beams with pedestal castings riveted to each end. The transom is of pressed steel and is made of one-half inch material. The transom is rigidly attached to the side frames by means of corner gussets, which includes the brake hanger fulcrums. The bolster is placed inside of the transom and is supported by triple elliptic springs carried by spring carrier bars, passing through and flexibly hung over the transom and corner castings.

TYPE OF TRUCK ON PENNSYLVANIA ELECTRIC CARS.

The body brake arrangement consists of two cylinder levers attached to a 12 inch by 8 inch brake cylinder. The other ends of the cylinder levers are directly connected to the equalizing bar passing through the center sills immediately above the center plate, which in turn are flexibly attached to two brake levers on each truck. The construction is of the same type as that now successfully in use on the other steel passenger service cars on the P. R. R. The truck brake consists of four levers, two on each side connected to brake shoes which are hung quite low, and the levers are connected in pairs by struts, the bottom of one lever being connected direct to the strut, thereby giving correspondingly more brake power on the motor wheels. No brake beams are used. The type of brake is that known as the Electro-Pneumatic. Each car is provided with a slack adjuster to insure uniform clearance between brake shoes and wheels and, therefore, uniform braking power.

The lighting is by means of incandescent lights well distributed throughout the car. The cars are heated by means of electric coils placed under the seats.

The motors are G. E. 212 type with commutating poles, having a nominal rating of 225 h.p., at 600 volts. The gear is carried on the extended hub of one wheel. The front side of motor frame is provided with two lugs which are supported by the truck transom and the axle bearing caps are bolted to vertically planed tongued surfaces on the frame. The motor can be mounted on, or removed from, the truck when run out from under the car without the use of a pit.

For emergency lighting, in case the power is cut off, small storage batteries have been provided to supply current. The cars are also equipped with electrically operated door signals and electrically controlled pneumatic engines for opening and closing the side doors.

These cars are 48 ft. long, 11 ft. 8½ inches high from rail to top of roof, and 8 ft. 10½ in. maximum width, and weigh 72,500 pounds.

PROPOSED LEGISLATION COMPELLING THE USE OF STEEL PASSENGER CARS

There were presented in the last Congress two bills requiring the substitution of steel or steel underframe passengers cars for wooden cars now in service. The first prohibits after January 1, 1912, the construction or use for the first time of any passenger train car not conforming to a standard to be designated by the American Railway Association to the Interstate Commerce Commission, which must include specifications as to steel underframe and superstructure. It provides that after January 1, 1918, no cars which do not comply with these standards can be used.

The other bill prohibits after June 1, 1915, the use of passenger train cars unless constructed of steel and upon a plan approved by the Interstate Commerce Commission.

An investigation of the equipment now in service covering 193 roads having 54,609 passenger train cars in service on December 31, 1910, and 4,074 cars put in service since that date, shows that of the cars contracted for or put into service during this year 62 per cent. are of steel, 14 per cent. steel underframe and 24 per cent. wood. It is estimated that on December 31, 1911, of all passenger train cars in service 9.3 per cent. will be of steel, 3.5 per cent. steel underframe and 87.2 per cent. wood. It is estimated that if all the present wooden equipment be replaced with all-steel equipment the cost would be $630,489,400. Further, it is estimated that if the present wooden equipment has an approximate value of $4,000 for each vehicle and if it is all replaced by steel there would be involved ultimately a charge to operating expenses under the classification of the Interstate Commerce Commission of about $187,604,000.

ZINC is said to be particularly effective in preventing corrosion due to electrolysis, as it is electropositive to iron and will protect iron or steel at its own expense as long as it is kept in contact with it. In accordance with this theory, the Chicago and North-Western is using a zinc insertion on the inner end of brass washout plugs. The zinc is cast in iron moulds and is screwed into the washout plug. The projecting end of zinc is 1¼ in. in diameter and 2¾ in. long. It is found that most of the zinc is eaten out in less than two weeks, and to that extent it has prevented corrosion and pitting by electrolytic action.

THE LONG ISLAND RAILROAD proved by means of experimental farms that the worst ten acres on the Island could be cultivated at a good profit, and the Pennsylvania R. R. has done the same thing with an experimental station at Bacon, Delaware. The land purchased had not been farmed for over five years. It had been robbed of its fertility several years earlier, and, considering it worthless, its owners let it grow up in sassafras, sweet briar and weeds. It was in this condition when the company's expert took charge. By a small application of stable manure, about 15 tons per acre, and 500 pounds of lime, corn was raised at the rate of 47 bushels an acre the first year.

ASSUMING THAT DETAIL CONTROL will produce and maintain maximum output, better quality, lowest cost; higher wages and contented employees and that, as a consequence, it meets with the approval and support of employers, what results may we be justified in looking for toward amelioration of some of the social evils which exist to-day, chief of which are the extremes of wealth and poverty.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE TOTAL OPEN MILEAGE OF THE SOUTH AFRICAN RAILWAYS is now 7,045, of which Cape Colony has 3,328 miles, Natal 995 miles, Orange River Colony 992 miles, and the Transvaal 1,730 miles. With lines authorized and those under construction the mileage will be increased nearly 1,000 miles.

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W. W. Morrow has been made general foreman of the Santa Fe at Prescott, Ariz., vice C. F. Ryer, resigned.

E. W. Cantwell has been made master boilermaker of the Big Four at Bellefontaine, O., vice J. R. Cushing, deceased.

F. M. Kerwin has been made roundhouse foreman of the Chicago, Rock Island & Pacific Ry. at Silvis, Ill., vice T. Kilpatrick, promoted.

W. H. Sample has been appointed master mechanic of the Grand Trunk Ry., at Ottawa, Ont., vice R. Cowan, assigned to other duties.

E. H. Bankard, purchasing agent of the Baltimore & Ohio R. R., has had his jurisdiction extended over the Cincinnati, Hamilton & Dayton Ry.

R. H. Collins has been appointed inspector of roundhouse and shop efficiency of the St. Louis & San Francisco R. R., with office at Springfield, Mo.

Millard F. Cox has been appointed mechanical engineer of the Louisville & Nashville, R. R., with office at Louisville, Ky., succeeding W. A. Stearns, resigned.

H. A. Fabian, manager of purchases and supplies of the Maine Central R. R., at Boston, Mass., has had his jurisdiction extended over the Portland Terminal Company, with office at Portland, Me.

J. W. Blakeburn, road foreman of engines of the St. Louis Southwestern Ry., at Pine Bluff, Ark., has been appointed master mechanic, with office at Pine Bluff, succeeding E. English, resigned.

G. W. Davis, general foreman of shops of the Texas & Pacific R. R. at Fort Worth, Tex., has been appointed master mechanic of that road and the International & Great Northern R. R., with office at Fort Worth, a new position.

J. D. Martin, master mechanic of the Trinity & Brazos Valley R. R., has been apointed superintendent of motive power, with office at Teague, Tex., vice C. H. Seabrook, resigned. The position of master mechanic has been abolished.

J. W. Small, superintendent of machinery of the Kansas City Southern R. R., at Pittsburg, Kan., has been appointed superintendent of machinery of the Missouri Pacific Ry., with office at St. Louis, Mo., succeeding G. W. Smith, resigned.

M. S. Curley, formerly master mechanic of the Frisco Lines at De Quincy, La., and formerly master mechanic of the Illinois Central R. R., at Paducah, has taken service with the O'Malley Bear Valve Co., Chicago, with office in Rand Building, Memphis, Tenn.

John P. Sykes, assistant general superintendent of the Baldwin Locomotive Works, Philadelphia, Pa., has been made general superintendent of the company, succeeding S. M. Vauclain, who held that position for the past 26 years, and who has now become vice-president.

P. M. Hammett, superintendent of motive power of the Maine Central R. R., has had his jurisdiction extended over the Portland Terminal Company, with office at Portland, Me. The jurisdiction of A. R. Manderson, assistant superintendent of motive power, is similarly extended.

M. J. McGraw has been appointed shop superintendent of the Missouri Pacific Ry. at Sedalia, Mo. The following additional shop superintendents are also announced: W. C. Smith, Kansas City; E. F. Stroch, Hoisington, Kans.; B. J. Peasley, De Soto, Mo., and B. E. Stevens, Argenta, Ark.

CATALOGS

Steel Tires.—The Standard Steel Works Company, Philadelphia, Pa., has issued a new catalogue on steel tires, giving in detail the specifications which were adopted by the American Society for Testing Materials. Illustrations, diagrams and a facsimile of dimension blank for orders are included.

High Tension Magnetos.—The Bosch Magneto Company, of New York, N. Y., has issued catalogs descriptive of its type "D. A. V." magneto for small and even cylinder "V" motors, and of the type "D. A. Q." for small single cylinder motors. These books are complete in every detail, with full information regarding the construction of the magnetos, and particularly so as regards the location of faults and directions for care and maintenance.

Electric Locomotives.—Bulletin No. 4851, just issued by the General Electric Company, is an attractive publication, containing data relative to the use of electricity in the service of steam roads. The publication comprises 48 pages, which illustrate and describe both station and road equipment of the New York Central and Hudson River Railroad; the Detroit Tunnel of the Michigan Central Road; the Cascade Tunnel of the Great Northern Railway; the equipment of the Baltimore & Ohio Railway, West Jersey and Seashore, the West Shore Railroad, etc.

Flexible Staybolts.—Under the title, "The Breakage of Staybolts," the Flannery Bolt Company, of Pittsburgh, Pa., has recently issued a very attractive and interesting publication. While intended primarily, no doubt, to advertise the merits of the Tate flexible staybolt, the book in reality is a treatise on the subject which its title implies. In addition to other valuable features it contains an analytic discussion on expansion in locomotive boilers, and a theoretical discussion on the breakage of staybolts. The book is well illustrated and carries the impress of the greatest care in the selection and presentation of the text. It will be of great assistance to those who are called upon to combat the vexatious problem with which it deals.

Furnace Slag in Concrete.—Under this title the Carnegie Steel Co. has published an interesting illustrated booklet, the object of which is to present to those interested the results of a series of tests of blast furnace slag, in various forms for use as an aggregate in the making of concrete. A study of the pages of the booklet will show that the aggregate performs a very important function, and that the strength of the concrete depends largely on the shape, character and strength of the aggregate. Any material which will improve the quality of the concrete without materially adding to its cost, must command the attention of the user, and it is believed that these results of some preliminary tests on blast furnace slag used in concrete will be of great value to the concrete engineer.

Articulated Compound Locomotives.—Bulletin 1009, just issued by the American Locomotive Company, contains an interesting illustrated description of the 230-ton articulated compound locomotives recently delivered by that firm to the Baltimore and Ohio Railroad. Ten locomotives were included in this order, and the design is at least 40 per cent heavier and more powerful than the pioneer articulated compound which was placed in service in 1904. The statement is made that twenty-one of the leading railroads of the country are now using an aggregate of 400 articulated locomotives. Nineteen of these have adopted this type within the past three years—four years or more since it was first introduced—which goes to prove that it has won favor through its known value from an operating standpoint.

NOTES

Bullard Machine Tool Co.—Announcement is made by this company that arrangements have been made with Harry Ellis, Jr., 1138 Mutual Bldg., Richmond, Va., for direct representation in the territory surrounding Richmond, and extending to the West Virginia line.

General Electric Co.—The Terre Haute, Indianapolis and Eastern Traction Company has placed an order with the General Electric Company for two 300-kw. rotary converters, fifteen 100-kva. transformers and a switchboard. The rotary converters and six of the transformers will be installed in the Maywood sub-station. Six of the transformers will be installed in the Mooresville sub-station, and three in the Martinsville sub-station.

Roberts & Schaefer Co.—The Roberts & Schaefer Co., engineers and contractors, Chicago, Ill., have recently secured a contract from the Oregon-Washington R. R. & Navigation Co. for the designing and building, complete in operation, of two Holmen locomotive coaling stations. One plant is to be installed at the Argo roundhouse at Seattle and is to be of 500 tons capacity with sand equipment. The other plant is to be installed at the new roundhouse at Tacoma, and is to be of 100 tons capacity. Approximate contract price for the above plants is $30,000.

Sprague Electric Works.—Frank W. Ball, manager of the Philadelphia office of the Sprague Electric Works, has been appointed manager of hoist sales and after July 15, 1911, will be located at the New York office. James A. Clifford, manager of the Baltimore office of the company, has been appointed manager of the Philadelphia office, and took charge there on July 1, 1911. The Baltimore office will be continued as in the past under Mr. Clifford's direction, but as subsidiary to the Philadelphia office and with Henry S. Patterson in charge.

Davis Bournonville Co.—Announcement is made that the business of this company will be divided into the Eastern Department, with offices in its present quarters, 90 West street, New York City, and the Western Department, with offices at 515 Laflin street, Chicago, the present quarters of the Chicago Welding Department of the National Pneumatic Company. It is believed that this consolidation will very materially assist the development of the welding and cutting industry, and the combined resources and experience of these companies will be at the service of prospective users of autogenous apparatus.

[illegible]ly as possible, along the center line of the parts. The center p[illegible] proper is bolted to the center plate backing casting, and [bet]ween the two a pocket is provided for use of centering [spri]ngs, allowing side motion of one inch between center line of body and center line of truck; the function of the springs [bein]g to form a cushion against side strains and to provide [com]fort in riding.

[E]ach truck has one motor axle and one trailer axle, and the [cen]ter is placed 2 inches out of center for the purpose of pro[vidin]g the same weight between wheel and rail for all the wheels [of] the truck. The side frames are of "H" beams with pedestal [cast]ings riveted to each end. The transom is of pressed steel [and] is made of one-half inch material. The transom is rigidly [atta]ched to the side frames by means of corner gussets, which [pro]vides the brake hanger fulcrums. The bolster is placed inside [the] transom and is supported by triple elliptic springs carried [on] spring carrier bars, passing through and flexibly hung over [the] transom and corner castings.

[illegible] TRUCK ON PENNSYLVANIA [ELECTRIC] CARS.

[The] body brake arrangement consists of two cylinder levers [atta]ched to a 12 inch by 8 inch brake cylinder. The other ends [of] the cylinder levers are directly connected to the equalizing [rods] passing through the center sills immediately above the center [pla]te, which in turn are flexibly attached to two brake levers on [the] truck. The construction is of the same type as that now [succe]ssfully in use on the other steel passenger service cars on [the] P. R. R. The truck brake consists of four levers, two on [eac]h side connected to brake shoes which are hung quite low, [an]d the levers are connected in pairs by struts, the bottom of [th]e lever being connected direct to the strut, thereby giving [co]rrespondingly more brake power on the motor wheels. No [br]ake beams are used. The type of brake is that known as the [El]ectro-Pneumatic. Each car is provided with a slack adjuster [to] insure uniform clearance between brake shoes and wheels and, [the]refore, uniform braking power.

[T]he lighting is by means of incandescent lights well distrib[ute]d throughout the car. The cars are heated by means of [elec]tric coils placed under the seats.

The motors are G. E. 212 type with commutating poles, having [a] nominal rating of 225 h.p., at 600 volts. The gear is carried [on] the extended hub of one wheel. The front side of motor [fr]ame is provided with two lugs which are supported by the [tr]uck transom and the axle bearing caps are bolted to vertically [pla]ned tongued surfaces on the frame. The motor can be [mo]unted on, or removed from, the truck when run out from [un]der the car without the use of a pit.

[Fo]r emergency lighting, in case the power is cut off, small [st]orage batteries have been provided to supply current. The [ca]rs are also equipped with electrically operated door signals [an]d electrically controlled pneumatic engines for opening and [clo]sing the side doors.

[Th]ese cars are 48 ft. long, 11 ft. 8½ inches high from rail to [to]p of roof, and 8 ft. 10½ in. maximum width, and weigh 72,500 [po]unds.

PROPOSED LEGISLATION COMPELLING THE USE OF STEEL PASSENGER CARS

There were presented in the last Congress two bills requiring the substitution of steel or steel underframe passengers cars for wooden cars now in service. The first prohibits after January 1, 1912, the construction or use for the first time of any passenger train car not conforming to a standard to be designated by the American Railway Association to the Interstate Commerce Commission, which must include specifications as to steel underframe and superstructure. It provides that after January 1, 1918, no cars which do not comply with these standards can be used.

The other bill prohibits after June 1, 1915, the use of passenger train cars unless constructed of steel and upon a plan approved by the Interstate Commerce Commission.

An investigation of the equipment now in service covering 193 roads having 54,600 passenger train cars in service on December 31, 1910, and 4,074 cars put in service since that date, shows that of the cars contracted for or put into service during this year 62 per cent. are of steel, 14 per cent. steel underframe and 24 per cent. wood. It is estimated that on December 31, 1911, of all passenger train cars in service 9.3 per cent. will be of steel, 3.5 per cent. steel underframe and 87.2 per cent. wood. It is estimated that if all the present wooden equipment be replaced with all-steel equipment the cost would be $930,489,400. Further, it is estimated that if the present wooden equipment has an approximate value of $4,000 for each vehicle and if it is all replaced by steel there would be involved ultimately a charge to operating expenses under the classification of the Interstate Commerce Commission of about $187,604,600.

ZINC is said to be particularly effective in preventing corrosion due to electrolysis, as it is electropositive to iron and will protect iron or steel at its own expense as long as it is kept in contact with it. In accordance with this theory, the Chicago and North-Western is using a zinc insertion on the inner end of brass washout plugs. The zinc is cast in iron moulds and is screwed into the washout plug. The projecting end of zinc is 1¼ in. in diameter and 2¾ in. long. It is found that most of the zinc is eaten out in less than two weeks, and to that extent it has prevented corrosion and pitting by electrolytic action.

THE LONG ISLAND RAILROAD proved by means of experimental farms that the worst ten acres on the Island could be cultivated at a good profit, and the Pennsylvania R. R. has done the same thing with an experimental station at Bacon, Delaware. The land purchased had not been farmed for over five years. It had been robbed of its fertility several years earlier, and, considering it worthless, its owners let it grow up in sassafras, sweet briar and weeds. It was in this condition when the company's expert took charge. By a small application of stable manure, about 15 tons per acre, and 500 pounds of lime, corn was raised at the rate of 47 bushels an acre the first year.

ASSUMING THAT DETAIL CONTROL will produce and maintain maximum output, better quality, lowest cost, higher wages and contented employees and that, as a consequence, it meets with the approval and support of employers, what results may we be justified in looking for toward amelioration of some of the social evils which exist to-day, chief of which are the extremes of wealth and poverty.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE TOTAL OPEN MILEAGE OF THE SOUTH AFRICAN RAILWAYS is now 7,045, of which Cape Colony has 3,328 miles, Natal 995 miles, Orange River Colony 992 miles, and the Transvaal 1,730 miles. With lines authorized and those under construction the mileage will be increased nearly 1,000 miles.

HEAVY DOUBLE-ENDED LOCOMOTIVES FOR MEXICO

One of three locomotives of the double-ender or Fairlie type which have recently been constructed by the Vulcan Foundry (Limited) at Newton-le-Willows, Lancashire, England, for the Mexican Railway is illustrated in the accompanying engravings. These locomotives are not only of outstanding interest by reason of being the heaviest ever built in Great Britain for the standard 4 ft. 8½ in. gauge, but they have had several novel features incorporated in their design. These three engines are intended to work mixed traffic, and to take trains weighing 300 tons up a 4 per cent. grade, combined with curves of 330 feet radius, and the tests in the builders' yards have shown the engines to be capable of passing without difficulty through a curve of 297 feet radius. The engine is mounted on two six-wheeled trucks, each driven by a pair of outside cylinders. There are no independent carrying wheels, so that the whole of the weight, 138 tons, or 23 tons per axle, is available for adhesion.

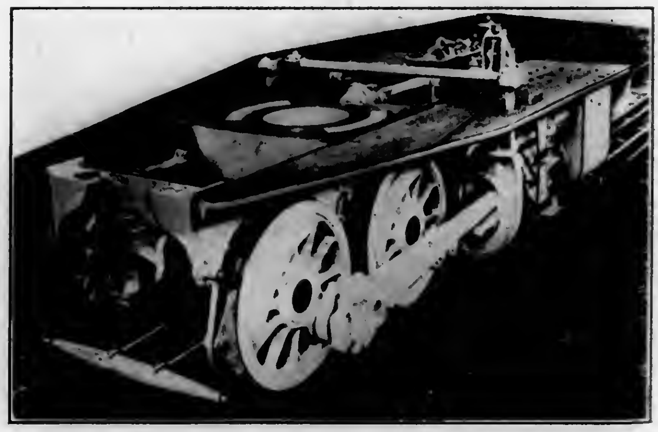
The boiler is built up of ⅝ in. steel plates for the two barrels, while the inner fireboxes are also of steel, 5/16 in. thick Taylor iron stays are employed between the fireboxes, the water space at the top being 8 in., tapering to 6 in. at the bottom. Each barrel contains 216 steel tubes 1⅞ in. diameter outside, by 12 ft. 11 in. between tube plates. One of the barrels is fitted with a steam dome on which are mounted four "Ashton" pop safety valves each 3½ in. in diameter, and there is also a cylindrical sandbox fitted immediately below the stack. The other barrel has no mountings, excepting the bell, but is provided with a manhole. The mud ring is formed in one piece without weld, and as a sample of construction constitutes something in the nature of a record.

FAIRLIE TYPE LOCOMOTIVE, MEXICAN RY.

The valve gears are of the Walschaert pattern, actuating Richardson balanced side valves, which latter work above the cylinders. A special feature of the valve mechanism is the reversing gear. This is operated by means of bevel gears from the reversing wheel, actuating a horizontal shaft running alongside the boilers and fireboxes, and connecting at each end with a diagonal shaft. This diagonal reversing shaft is fixed on each truck with a quadrant and worm gearing, and flexibility is insured by providing it with a universal ball and socket joint at either end, while the movement of the truck is compensated for by the provision of a slot and sleeve arrangement as part of the diagonal shaft. In some designs of Fairlie locomotives, difficulty has been experienced from the fact that as the trucks enter or leave a curve, the position of the valve motion has been slightly altered by reason of the fact that the reversing shaft is rigidly connected to the die-block. In the present instance, any shifting of the position is rendered absolutely impossible, no matter what the relation between the trucks and other parts of the construction may be. The motion is locked by a special locking cylinder operated off the Westinghouse brake apparatus. The footplate is so arranged that the controlling apparatus is placed entirely on the side where the engineer is situated, while the fireman occupies a position opposite thereto, so that there may be no impediment in his way when firing.

The engine is fitted with side water tanks sloping towards the front ends to facilitate the view ahead. Above the tanks and extending across the boiler are the coal bunkers. A supplementary well tank is provided on each side, below the footplate, in connection with the side water tanks. The main principle on which the engine is constructed does not vary from that of the usual Fairlie type, flexibility of movement being obtained by the use of ball-and-socket joints and similar means. All the springs in each truck are compensated. The equipment includes the Westinghouse E. T. brake apparatus with signaling device, while a hand brake acting on all wheels is provided.

Two throttle handles are provided, these being mounted one above the other horizontally and working in a toothed quadrant, the arrangement being such that either engine can be used independently of the other. The engines are so arranged that they can be fitted with oil fuel burning apparatus at a later period, but as sent out from the Vulcan Foundry they are built for coal consumption, with rocking grates.



ONE OF THE TRUCKS COMPLETE.

The following are some of the principal dimensions:

Cylinders (4), diameter	19 in.
Stroke of pistons	25 in.
Wheelbase (each truck)	9 ft. 3 in.
Total wheelbase	35 ft. 6 in.
Total length over all	56 ft. 1¾ in.
Boilers, length of barrels	13 ft.
Boilers, diameter of barrels	5 ft. outside.
Boilers, height of centre above rail	7 ft. 10 in.
Heating surface, total	2,984 sq. ft.
Grate area	47.75 sq. ft.
Working pressure	185 lbs.
Weight in full working order	138 tons

At 90 per cent. of the boiler pressure the engine develops a tractive force of 62,610 lbs. and at 75 per cent. 52,176 lbs. The ratio of tractive force at 90 per cent. to adhesion is 4.34 and at 75 per cent. 5.9. The tanks have a carrying capacity of 4,500 gallons and a fuel space of 7 tons is provided.

GENERAL FOREMEN'S CONVENTION

The seventh annual convention of the International Railway General Foremen's Association was held at the New Sherman Hotel, Chicago, July 25-27, C. H. Boges, president, presiding.

L. H. Bryant, secretary, reported a membership of 215 and a very satisfactory balance in the treasury.

In addition to the reports presented and discussed at the meeting, addresses were delivered on each of the three afternoon sessions by J. F. DeVoy, H. T. Bentley and Dr. Angus Sinclair in the order named.

Although there were four committees appointed to report at this meeting but two of them were prepared to do so and the report of the committee on Shop "Kinks" was really merged into the report of F. C. Pickard on "How Can Shop Foremen Best Promote Efficiency?" so that the discussion of this report occupied the full time of the convention. Mr. Pickard's report was so well prepared, and arranged in such a form, that although the whole time of the convention was given up to it the subject was by no means exhausted and it is doubtful if double the time would have sufficed.

This report was divided into a number of sections as follows: Organization, accounting and supervision, handling of material, shop methods, tool room efficiency and shop "kinks." Under each of these headings were given a carefully studied series of questions on the most important features of that subject. These questions had previously been sent to the members, who were asked to come prepared to discuss them. When the report was taken up each question was brought up and the discussion finished on it before the next one on the same subject was taken up. In this manner the meeting discussed 40 or 50 independent phases, all dealing with the same subject, a novelty of procedure which has very much to recommend it for conventions of this class.

The discussion on each phase of the various subjects was largely confined to reports by the various members of the methods in use at their shop, although occasionally there would be given some very valuable advice and suggestions on the subject in the abstract. The same difficulty appeared at this meeting that is present at all meetings of railroad men, at least in the motive power department, viz., the absence of helpful criticisms. While members explained, in some cases in detail, the systems in use at their shops, they did not feel free to give the convention the benefit of the weak points in the arrangement or system, confining themselves entirely to pointing out the valuable features or to a simple recital of the method.

Under the head of organization the first question was "What Plan of Organization Do You Find to Be Most Effective?" This aroused a lively discussion, largely along the lines mentioned above, although a number of members brought out some of the most important principles of good organization. As an instance of this, W. C. Steers stated, "a general foreman should have an organization such that each foreman knows just exactly how far he should go and where the line is drawn between his department and the other departments." Other members pointed out that the best form of organization depends upon local conditions and upon the size of the shop, and several mentioned the great difficulty which is often present due to lack of sufficient supervision. W. Smith, C. & N. W., spoke strongly on this feature. The weekly meetings of heads of departments were generally recommended and card systems for keeping track of repairs have been found most valuable. The importance of building up a shop organization by promoting men from the ranks was mentioned and strongly advised.

The second question under this head was "Do you find that strong leadership, force of personality, and the way of doing things will accomplish much?" In the discussion it was clearly brought out that certain features of personality were of great importance and that the foreman must be a real leader who is loyal to the company and can inspire the confidence of his men.

In discussing the question "Do you find that the test of an organization is the maintaining of efficiency during the absence of an important unit?" W. C. Rayer, in reporting their practice, brought out an important feature influencing results when a foreman is absent. This refers to the practice that the man who is temporarily promoted and assumes increased responsibilities is given the pay of the position which he temporarily occupies during the time he is in it.

It seemed to be the general opinion of the members that unsatisfactory results following the absence of an important member of the organization indicated a weak spot in the organization which should not exist.

Under the head of accounting and supervision the system which would permit a daily knowledge of exactly the cost of the work done during each day was generally recommended.

There was not sufficient time to discuss the questions under the handling of material, but the discussion on shop methods was very extensive and lively. Specialization and standardization of work, men and methods was strongly advocated, as was also the systematization of all possible features.

During the discussion of the advantage of shop devices, in which was included the report of the committee on shop "kinks," it was strongly urged by many members that all possible inducements be offered to the men in the shop to suggest tools, devices or methods which would improve the output or work, and it was suggested that one excellent way to improve matters along this line was to permit foremen and workmen to visit the shops of other companies and see what is being done there.

Election of Officers.—F. C. Pickard, M. M., C. H. & D., Indianapolis, was elected president; J. A. Boyden, Hornell Shops, Erie R. R., first vice-president; T. F. Griffen, C., C. & St. L., Indianapolis, second vice-president; W. Smith, C. & N. W., Freemont, third vice-president; L. S. North, Illinois Central, Chicago, fourth vice-president, and L. H. Bryan, D. & I. R., Two Harbors, Mich., secretary and treasurer.

ENTERTAINMENT AND EXHIBITS.

The entertainment program included a visit to the plant of Jos. T. Ryerson & Sons, where luncheon was served and a demonstration of machine tools was given. On Wednesday and Friday evenings the Marshall & Huschart Mach. Co. entertained many members at its store with demonstrations of machine tools and a vaudeville entertainment. The tools operated or exhibited at this point included typical examples of the line manufactured by the following companies as shown:

Bullard Machine Tool Company.—42-in. vertical turret lathe.
Rockford Drilling Machine Company.—24-in. spindle gang drill, a 20-in. drill.
Cincinnati Bickford Company.—36-in. new pattern radial drill and a 24-in. tapping drill on high-speed drilling.
Cincinnati Milling Machine Company—Milling cutters shown on both roughing and finishing work on vertical and horizontal millers.
Landis Machine Company.—1½-in. bolt cutter.
Gould & Eberhardt.—44-in. electrically driven shaper and a 12-in. gear generator.
Von Wick Machine Company, Cincinnati.
Gardner Machine Company, Beloit, Wis.—Pattern-making machine and a double-disc grinder.
Lodge & Shipley Machine Tool Company.—Patent head lathe display.
Cincinnati Planer Company.—36-in. planer having three heads and a two-speed countershaft.
Acme Machine Tool Company, Cincinnati.—2¼-in. screw machine, fully equipped.
Reliance Electric Machine Company, Cleveland.—Motor for machine-tool drive in which the armature may be moved laterally.

Among the exhibitors at the Hotel were the following firms:

Andreon Manufacturing Company, St. Louis, Mo.
American Arch Company, New York.
American Steel Foundries, Chicago.
Anchor Packing Company, Philadelphia, Pa.
Armstrong Bros. Tool Company, Chicago.
Ashcroft Manufacturing Company.
Ashton Valve Company, Boston, Mass.
Barrett Manufacturing Company, New York.
Bowser & Co., S. F., Fort Wayne, Ind.
Carborundum Company, Niagara Falls, N. Y.
Carpenter Steel Company, Chicago.
Celfor Tool Company, Chicago.
Chicago Pneumatic Tool Company, Chicago.
Chicago Railway Equipment Company, Chicago.
Consolidated Safety Valve Company.
Crane Company, Chicago.
Crucible Steel Company of America, Pittsburgh, Pa.
Dearborn Drug and Chemical Works, Chicago.
Detroit Lubricator Company, Detroit.
Dixon Crucble Company, Joseph, Jersey City, N. J.
Emery Pneumatic Lubricator Company, St. Louis, Mo.
Fairbanks, Morse & Company, Chicago.
Firth Stirling Steel Company, Pittsburgh: E. S. Jackman & Co., agents.
Garlock Packing Co., Palmyra, N. Y.
Geometric Tool Company, New Haven, Conn.
Goldschmidt Thermit Company, New York.
Greene, Tweed & Co., New York.
Hancock Inspirator Company.
Hoskins Manufacturing Company, Chicago.
Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Independent Pneumatic Tool Company, Chicago.

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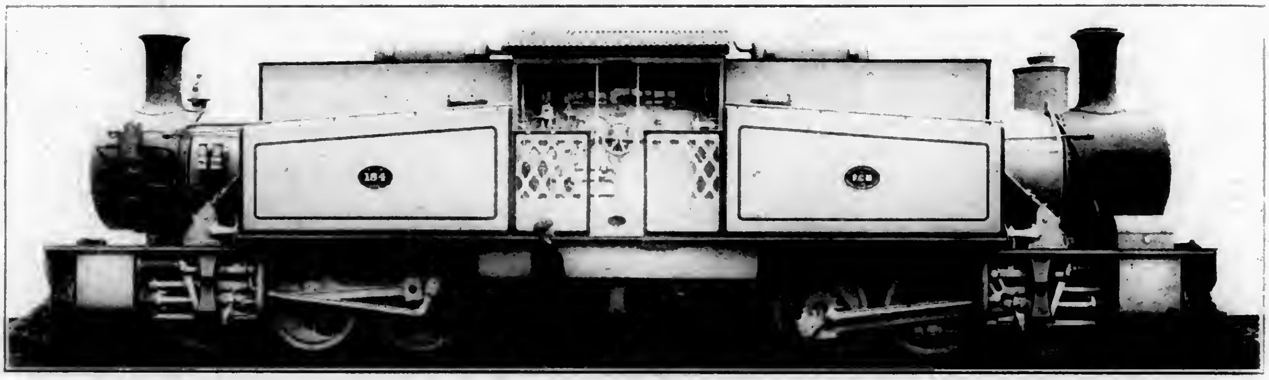

FAIRLIE-TYPE LOCOMOTIVE, MEXICAN RY.

be capable of passing without difficulty through a curve of 207 feet radius. The engine is mounted on two six-wheeled trucks, each driven by a pair of outside cylinders. There are no independent carrying wheels, so that the whole of the weight, 138 tons, or 23 tons per axle, is available for adhesion.

The valve gears are of the Walschaert pattern, actuating Richardson balanced side valves, which latter work above the cylinders. A special feature of the valve mechanism is the reversing gear. This is operated by means of bevel gears from the reversing wheel, actuating a horizontal shaft running alongside the boilers and fireboxes, and connecting at each end with a diagonal shaft. This diagonal reversing shaft is fixed on each truck with a quadrant and worm gearing, and flexibility is insured by providing it with a universal ball and socket joint at either end, while the movement of the truck is compensated for by the provision of a slot and sleeve arrangement as part of the diagonal shaft. In some designs of Fairlie locomotives, difficulty has been experienced from the fact that as the trucks enter or leave a curve the position of the valve motion has been slightly altered by reason of the fact that the reversing shaft is rigidly connected to the die-block. In the present instance, any shifting of the position is rendered absolutely impossible, no matter what the relation between the trucks and other parts of the construction may be. The motion is locked by a special locking cylinder operated off the Westinghouse brake apparatus. The footplate is so arranged that the controlling apparatus is placed entirely on the side where the engineer is situated, while the fireman occupies a position opposite thereto, so that there may be no impediment in his way when firing.

The engine is fitted with side water tanks sloping towards the front ends to facilitate the view ahead. Above the tanks and extending across the boiler are the coal bunkers. A supplementary well tank is provided on each side, below the footplate, in connection with the side water tanks. The main principle on which the engine is constructed does not vary from that of the usual Fairlie type, flexibility of movement being obtained by the use of ball-and-socket joints and similar means. All the springs in each truck are compensated. The equipment includes the Westinghouse E. T. brake apparatus with signaling device, while a hand brake acting on all wheels is provided.

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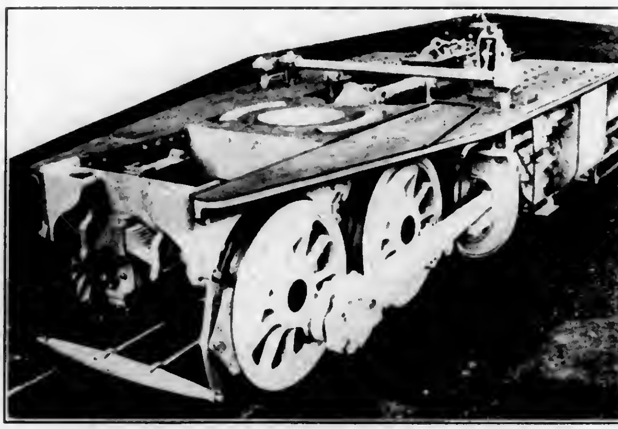


ONE OF THE TRUCKS COMPLETE.

can be fitted with oil fuel burning apparatus at a later peri but as sent out from the Vulcan Foundry they are built f coal consumption, with rocking grates.

The following are some of the principal dimensions:

Cylinders (4), diameter	19
Stroke of pistons	25
Wheelbase (each truck)	9 ft. 3
Total wheelbase	35 ft. 6
Total length over all	56 ft. 1¾ i
Boilers, length of barrels	13 ft.
Boilers, diameter of barrels	5 ft. outsid
Boilers, height of centre above rail	7 ft. 10
Heating surface, total	2,984 sq. ft
Grate area	47.75 sq. ft
Working pressure	185 lbs
Weight in full working order	138 tons

At 90 per cent. of the boiler pressure the engine develops a tractive force of 62,610 lbs., and at 75 per cent. 52,170 lbs. The ratio of tractive force at 90 per cent. to adhesion is 4.34 an at 75 per cent. 5.9. The tanks have a carrying capacit of 4,50 gallons and a fuel space of 7 tons is provided.

GENERAL FOREMEN'S CONVENTION

The seventh annual convention of the International Railway General Foremen's Association was held at the New Sherman Hotel, Chicago, July 25-27, C. H. Boges, president, presiding.

L. H. Bryant, secretary, reported a membership of 215 and a very satisfactory balance in the treasury.

In addition to the reports presented and discussed at the meeting, addresses were delivered on each of the three afternoon sessions by J. F. DeVoy, H. T. Bentley and Dr. Angus Sinclair in the order named.

Although there were four committees appointed to report at this meeting but two of them were prepared to do so and the report of the committee on Shop "Kinks" was really merged into the report of F. C. Pickard on "How Can Shop Foremen Best Promote Efficiency?" so that the discussion of this report occupied the full time of the convention. Mr. Pickard's report was so well prepared, and arranged in such a form, that although the whole time of the convention was given up to it the subject was by no means exhausted and it is doubtful if double the time would have sufficed.

This report was divided into a number of sections as follows: Organization, accounting and supervision, handling of material, shop methods, tool room efficiency and shop "kinks". Under each of these headings were given a carefully studied series of questions on the most important features of that subject. These questions had previously been sent to the members, who were asked to come prepared to discuss them. When the report was taken up each question was brought up and the discussion finished on it before the next one on the same subject was taken up. In this manner the meeting discussed 40 or 50 independent phases, all dealing with the same subject, a novelty of procedure which has very much to recommend it for conventions of this class.

The discussion on each phase of the various subjects was largely confined to reports by the various members of the methods in use at their shop, although occasionally there would be given some very valuable advice and suggestions on the subject in the abstract. The same difficulty appeared at this meeting that is present at all meetings of railroad men, at least in the motive power department, viz., the absence of helpful criticisms. While members explained, in some cases in detail, the systems in use at their shops, they did not feel free to give the convention the benefit of the weak points in the arrangement or system, confining themselves entirely to pointing out the valuable features or to a simple recital of the method.

Under the head of organization the first question was "What Plan of Organization Do You Find to Be Most Effective?" This aroused a lively discussion, largely along the lines mentioned above, although a number of members brought out some of the most important principles of good organization. As an instance of this, W. C. Steers stated, "a general foreman should have an organization such that each foreman knows just exactly how far he should go and where the line is drawn between his department and the other departments." Other members pointed out that the best form of organization depends upon local conditions and upon the size of the shop, and several mentioned the great difficulty which is often present due to lack of sufficient supervision. W. Smith, C. & N. W., spoke strongly on this feature. The weekly meetings of heads of departments were generally recommended and card systems for keeping track of repairs have been found most valuable. The importance of building up a shop organization by promoting men from the ranks was mentioned and strongly advised.

The second question under this head was "Do you find that strong leadership, force of personality, and the way of doing things will accomplish much?" In the discussion it was clearly brought out that certain features of personality were of great importance and that the foreman must be a real leader who is loyal to the company and can inspire the confidence of his men.

In discussing the question "Do you find that the test of an organization is the maintaining of efficiency during the absence of an important unit?" W. C. Rayer, in reporting their practice, brought out an important feature influencing results when a foreman is absent. This refers to the practice that the man who is temporarily promoted and assumes increased responsibilities is given the pay of the position which he temporarily occupies during the time he is in it.

It seemed to be the general opinion of the members that unsatisfactory results following the absence of an important member of the organization indicated a weak spot in the organization which should not exist.

Under the head of accounting and supervision the system which would permit a daily knowledge of exactly the cost of the work done during each day was generally recommended.

There was not sufficient time to discuss the questions under the handling of material, but the discussion on shop methods was very extensive and lively. Specialization and standardization of work, men and methods was strongly advocated, as was also the systematization of all possible features.

During the discussion of the advantage of shop devices, in which was included the report of the committee on shop "kinks," it was strongly urged by many members that all possible inducements be offered to the men in the shop to suggest tools, devices or methods which would improve the output or work, and it was suggested that one excellent way to improve matters along this line was to permit foremen and workmen to visit the shops of other companies and see what is being done there.

Election of Officers.—F. C. Pickard, M. M., C. H. & D., Indianapolis, was elected president; J. A. Boyden, Hornell Shops Erie R. R., first vice president; T. F. Griffen, C., C. & St. L., Indianapolis, second vice president; W. Smith, C. & N. W., Freemont, third vice president; L. S. North, Illinois Central, Chicago, fourth vice-president, and L. H. Bryan, D. & I. R., Two Harbors, Mich., secretary and treasurer.

ENTERTAINMENT AND EXHIBITS.

The entertainment program included a visit to the plant of Jos. T. Ryerson & Sons, where luncheon was served and a demonstration of machine tools was given. On Wednesday and Friday evenings the Marshall & Huschart Mach. Co. entertained many members at its store with demonstrations of machine tools and a vaudeville entertainment. The tools operated or exhibited at this point included typical examples of the line manufactured by the following companies as shown:

Bullard Machine Tool Company.—42-in. vertical turret lathe.
Rockford Drilling Machine Company.—24-in. spindle gang drill, a 20-in. drill.
Cincinnati Bickford Company.—36-in. new pattern radial drill and a 24-in. tapping drill on high-speed drilling.
Cincinnati Milling Machine Company—Milling cutters shown [illegible] roughing and finishing work on vertical and horizontal millers.
Landis Machine Company.—1 [illegible]-in. bolt cutter.
Gould & Eberhardt.—14-in. electrically driven shaper and a [illegible] generator.
Von Wick Machine Company, Cincinnati.
Gardner Machine Company, Beloit, Wis.—Pattern-making machine and a double-disc grinder.
Lodge & Shipley Machine Tool Company.—Patent head lathe display.
Cincinnati Planer Company.—36-in. planer having three heads and a two-speed counter-shaft.
Acme Machine Tool Company, Cincinnati.—2 [illegible]-in. screw machine, fully equipped.
Reliance Electric Machine Company, Cleveland.—Motor for machine tool drive, in which the armature may be moved laterally.

Among the exhibitors at the Hotel were the following firms:

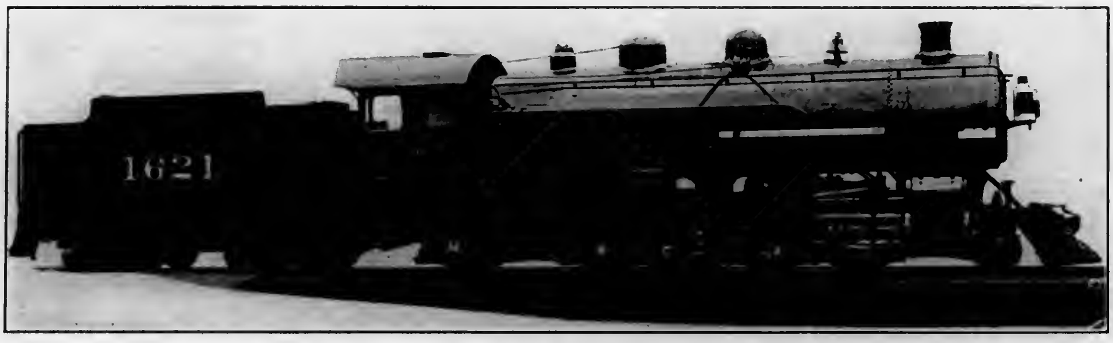
Andreon Manufacturing Company, St. Louis, Mo.
American Arch Company, New York.
American Steel Foundries, Chicago.
Anchor Packing Company, Philadelphia, Pa.
Armstrong Bros. Tool Company, Chicago.
Ashcroft Manufacturing Company.
Ashton Valve Company, Boston, Mass.
Barrett Manufacturing Company, New York.
Bowser & Co., S. F., Fort Wayne, Ind.
Carborundum Company, Niagara Falls, N. Y.
Carpenter Steel Company, Chicago.
Celfor Tool Company, Chicago.
Chicago Pneumatic Tool Company, Chicago.
Chicago Railway Equipment Company, Chicago.
Consolidated Safety Valve Company.
Crane Company, Chicago.
Crucible Steel Company of America, Pittsburgh, Pa.
Dearborn Drug and Chemical Works, Chicago.
Detroit Lubricator Company, Detroit.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Emery Pneumatic Lubricator Company, St. Louis, Mo.
Fairbanks, Morse & Company, Chicago.
Firth Stirling Steel Company, Pittsburgh; E. S. Jackman & Co., agents.
Garlock Packing Co., Palmyra, N. Y.
Geometric Tool Company, New Haven, Conn.
Goldschmidt Thermit Company, New York.
Greene, Tweed & Co., New York.
Hancock Inspirator Company.
Hoskins Manufacturing Company, Chicago.
Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Independent Pneumatic Tool Company, Chicago.

Jenkins Bros., New York.
Johns-Manville Company, New York.
Leslie Company, Lyndhurst, N. J.
Locomotive Improvement Company, Clinton, Iowa.
Locomotive Superheater Company, New York.
Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.
Manning, Maxwell & Moore, Inc., New York.
Marshall Ventilated Mattress Company, Chicago, Ill.
Marshall & Huschcart Machinery Company, Chicago.
Matthews-Davis Tool Company, St. Louis, Mo.
McCord & Co., Chicago.
McCrosky Reamer Company, Inc., Meadville, Pa.
McMaster Car Supply Company, Chicago.
Nathan Manufacturing Company, New York.
National Boiler Washing Company, Chicago.
National Machinery Company, Tiffin, Ohio.
Oakgrove Handle Company, Cameron, Wis.
O'Malley-Beare Valve Company, Chicago.
Otley Manufacturing Company, Chicago.
Pilliod Company, Swanton, Ohio.
Pratt & Letchworth Co., Buffalo, N. Y.
Pyle-National Electric Headlight Company, Chicago.
Ryerson & Son, Joseph T., Chicago.
Safety Car Heating & Lighting Company, New York.
Storrs Mica Company, Owego, N. Y.
Templeton-Kenly Company, Chicago.
United States Metal and Manufacturing Company, New York.
United States Metallic Packing Company, Philadelphia, Pa.

Superheater Freight Locomotive 2-8-2 Type

ILLINOIS CENTRAL RAILROAD

Although the consolidation type locomotive has for a number of years held undisputed control as the leading freight locomotive for heavy work in level districts, the signs of progress for this particular purpose have recently been numerous and the 2-8-2, or Mikado, type, which has laid practically dormant for many years, is now becoming popular and bids fair to oust the consolidation from its position of supremacy. The reason for this change is the same that has controlled the popularity of all types of locomotives in the past, that is, boiler capacity coupled with the ability to increase the average speed of heavy trains. A powerful boiler usually means a heavy boiler and a long one, and while the maximum tractive effort of the Mikado can usually be obtained by the consolidation type, a sustained high tractive effort, which depends upon the boiler capacity, can be better assured by the latter.



MIKADO TYPE LOCOMOTIVE WITH HIGH DEGREE SUPERHEATER AND LOW BOILER PRESSURE.

Consider the particular locomotive here illustrated, which weighs 218,300 lbs. on drivers, giving an average weight on the rail per pair of 54,570 lbs. If this firebox was made shallower and the wheels spread apart, giving a consolidation locomotive, the boiler being otherwise the same, the average weight on the rail per pair of driving wheels would be nearly 65,000 lbs. and the capacity of the boiler would probably be considerably affected by the more shallow firebox while the drawbar pull at the 20 miles per hour would not be any larger if as large with the consolidation engine and the value of the greater weight on the drivers would be lost.

It is this and features of maintenance which are making the Mikado type the successor of the consolidation.

In the 50 engines recently delivered by the Baldwin Locomotive Works to the Illinois Central Railroad high degree Schmidt superheaters having 1,093 sq. ft. of heating surface in 36 elements have been applied. At the same time the boiler pressure specified is 175 lbs. and the pistons applied are 27 in. in diameter. If 200 lbs. of steam were used in this case the same tractive effort would have been obtained with cylinders 25¼ in. diameter, which would have presented 360 sq. in., or over 7 per cent. less area of wall exposed in the two cylinders. If saturated steam were used it would be somewhat doubtful if sufficient gain would be made from the lower pressure to justify the increased condensation, but since high degree superheated steam is actually being used and the clearance of the road permits 27-in. cylinders this action is thoroughly justified and most advisable, not only from the probable reduction in boiler maintenance, but also from the fact that the same temperature of flue gases will give a higher superheat to the steam and as is now generally known, it is at the higher degrees of superheat that the greatest economy is obtained. Economy means capacity.

It is evident from the size of the superheater in relation to the size of the boiler that high temperatures are expected and that the designers have the courage of their convictions on this point and propose to get the full benefit therefrom. In this boiler there is one square foot of superheater heating surface to 3.72 sq. ft. of evaporative heating surface, a ratio considerably higher than has been used in the past.

It is interesting to investigate the amount of evaporative heating surface that is lost by the installation of the superheater. If the flues were spaced at the same centers and no superheater tubes had been installed this boiler would have contained about 440 flues. This would have given 4,723 sq. ft. of heating surface, which combined with the firebox would have made the total heating surface of the boiler 4,958 sq. ft., or 890 sq. ft. more than the evaporative surface is at present, the loss in number of tubes being 178 approximately, partially offset by the 36 5⅜-in. tubes. In place of this 890 sq. ft. of evaporative heating surface there has been gained 1,093 sq. ft. of super heater heating surface, which it is believed is 1½ times as valuable as an equal surface in the tubes and on this basis gives 1,640 sq. ft., or a total equivalent heating surface in the present boiler of 5,708 sq. ft. If it is true that superheating heating surface is 1½ times as valuable as evaporative heating surface it appears an equivalent gain of 850 sq. ft. of heating surface, or 17 per cent., has been made in this boiler by the application of the superheater.

Advantage has been taken of the wheel arrangement in obtaining a good depth of throat sheet and the bottom of the mud ring at the front end is 27 in. below the barrel. The mud ring is 5 in. wide on all sides and the back head and throat sheet are sloped in the usual manner. A single fire door is employed and the general arrangement and dimensions of the firebox are of the customary radial stayed type.

A feature noticed in this locomotive which has not been used to any extent for a long time is the application of steam jets through the sides of the firebox just above the fuel bed level. Here are found four steam jets on either side, spaced about 20 in. apart from the front end of the firebox and about the same distance above the grate level, being approximately on a level with the bottom row of tubes. Each of these consists of a 2-in. tube through the side water legs, in which are placed steam nozzles, the supply being drawn from the turret in the cab.

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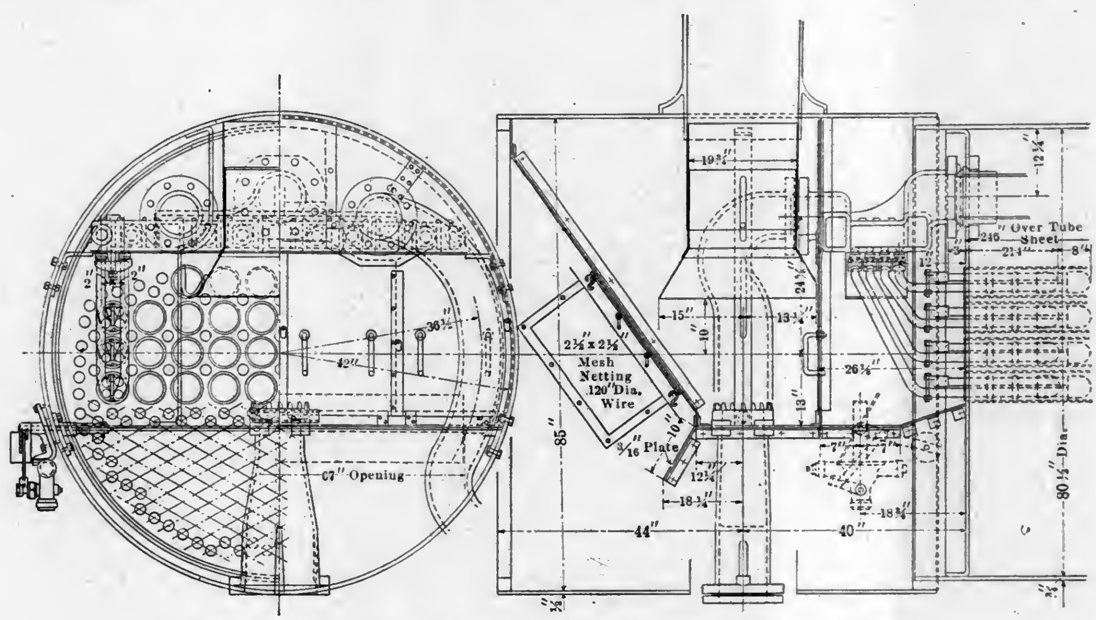
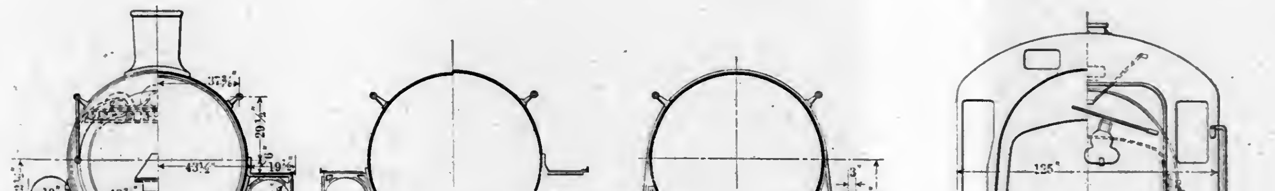


ARRANGEMENT OF SCHMIDT SUPERHEATER IN ILLINOIS CENTRAL LOCOMOTIVE.



ELEVATION AND SECTIONS OF POWERFUL 2-8-2 TYPE LOCOMOTIVE FOR THE ILLINOIS CENTRAL R. R.

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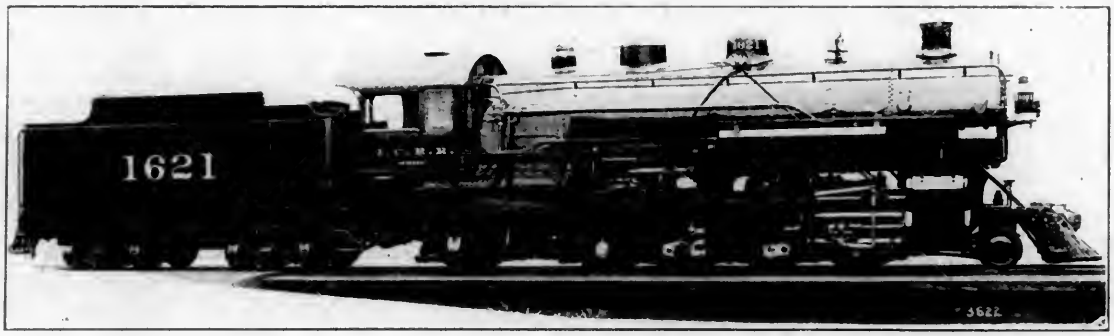

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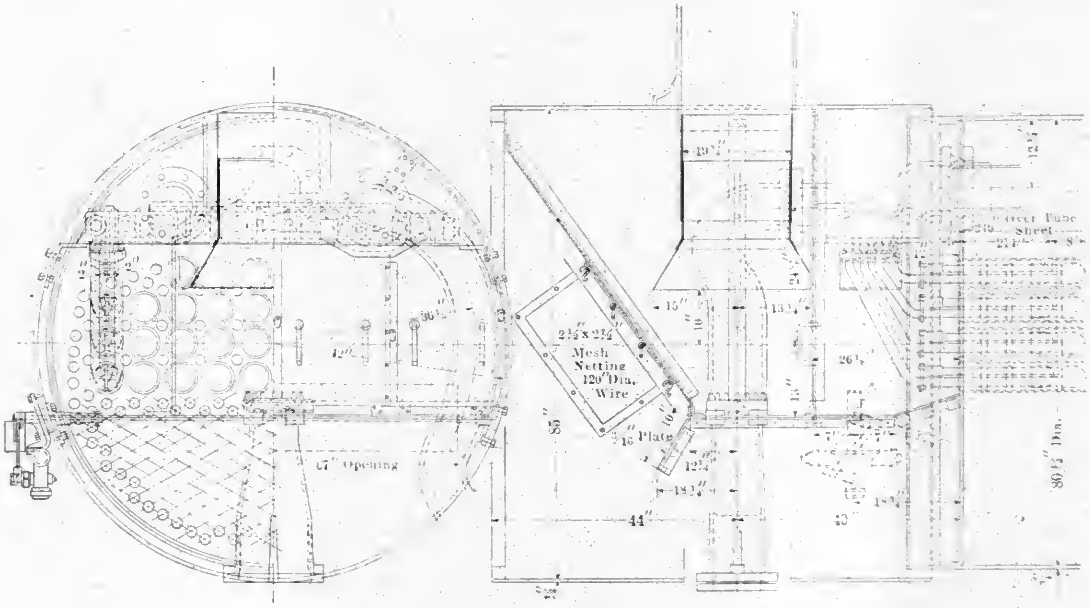

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ELEVATION AND SECTIONS OF POWERFUL 2-8-2 TYPE LOCOMOTIVE FOR THE ILLINOIS CENTRAL R. R.

steam pipes out through the side of the front end of the boiler and connecting them to the top of the steam chests. In this case there is a steel flange riveted to the outside of the smokebox to which is secured a malleable iron sleeve, making a tight joint with it and also the boss on the top of the steam chest. The steam pipe passes through this flange and sleeve.

A bushing ¾ in. thick is provided in the cylinders, a practice that has much to recommend it. Although superheated steam is used 15-in. piston valves have been provided. Foreign practice with high degree superheated steam has indicated that considerably smaller valves can be used and it is probable that these are larger than will actually be necessary under the conditions.

The valves have a maximum travel of 6½ in., a steam lap of 1¼ in., no exhaust lap or clearance and are set with a lead of ¼ in. No circulating valves have been provided, but a vacuum relief valve is tapped into the outer wall of the steam chest above the live steam compartment.

Cast steel frames 4½ in. wide with double front rails and most substantial bracing are used. The equalization system is divided between the first and second pair of drivers and the Hodges type of trailing truck fitted with a centering spring is applied.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	51,700 lbs.
Weight in working order	283,850 lbs.
Weight on drivers	218,300 lbs.
Weight on leading truck	25,050 lbs.
Weight on trailing truck	40,500 lbs.
Weight of engine and tender in working order	455,000 lbs.
Wheel base, driving	16 ft. 6 in.
Wheel base, total	35 ft. 2 in.
Wheel base, engine and tender	65 ft. 1⅜ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.23
Total weight ÷ tractive effort	5.50
Tractive effort × diam. drivers ÷ equivalent heating surface*	570.00
Total heating surface ÷ grate area	58.10
Firebox heating surface ÷ total heating surface per cent	5.80
Weight on drivers ÷ total heating surface	53.80
Total weight ÷ total heating surface	69.80
Volume both cylinders cu. ft	20.00
Equivalent heating surface ÷ vol. cylinders	285.40
Grate area ÷ vol. cylinders	3.5
CYLINDERS.	
Kind	Simple
Diameter and stroke	27 x 30
VALVES.	
Kind	Piston
Diameter	15 in.
Greatest travel	6½ in.
Outside lap	1¼ in.
Inside clearance	0 in.
Lead	¼ in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	30½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Straight
Working pressure	175 lbs.
Outside diameter of first ring	82 in.
Firebox, length and width	120⅝ x 84 in.
Firebox plate, thickness	⅜ & ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	36—5⅜ & 262—2 in.
Tubes, length	20 ft. 6 in.
Heating surface, tubes	3,833 sq. ft.
Heating surface, firebox	235 sq. ft.
Heating surface, total	4,068 sq. ft.
Superheater heating surface	1,093 sq. ft.
Grate area	70 sq. ft.
Center of boiler above rail	119½ in.
TENDER.	
Frame	12 in. 40 lb. chan.
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,000 gals.
Coal capacity	15 tons

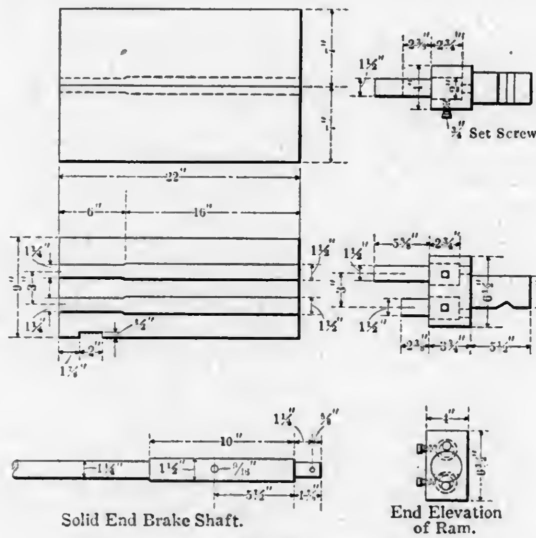
* Equivalent heating surface = total heating surface plus 1.5 times superheating surface = 5,708 sq. ft.

The New York Central has been granted eighteen months' more time to complete the improvements now under way at the Grand Central Terminal, New York, according to the final plans adopted by the Board of Estimate.

DIES FOR UPSETTING BRAKE SHAFT ENDS

The recent rule of the Interstate Commerce Commission in regard to safety appliances on all new equipment makes it necessary that the practice of welding be discontinued on brake shafts, and therefore the most practical and economical method for getting them out becomes a matter of much interest for practically every railroad shop in the country. The new rules call for the drum of the brake shaft to be 1½ in. in diameter, while 1¼ in. is permitted for the other portion of the shaft, and with a weld not permissible, the handling of the part becomes somewhat complicated, apparently necessitating either the upsetting of the 1¼ in. stock, or the drawing down of the 1½ in. stock.

Appreciating the expense attached to the latter method, the



DETAILS OF BRAKE SHAFT DIES.

motive power department of the Central of Georgia Railway, with its usual ingenuity in dealing with such problems, has devised very efficient dies for upsetting the 1¼ in. stock, and eliminating entirely any weld in the brake shaft. These dies, which are shown in the accompanying drawing, are used in a 4 in. forging machine, and at the Macon shops of this road they find that a brake shaft can now be upset by their use at much less cost even than the weld could be made between the two different sizes of stock. While the drawing shows only the upsetting die, other dies are also in use for squaring the upper end of the shaft for the brake wheel, and for punching the brake chain hole, thus rendering the entire job throughout machine forged.

The Headquarters of The American Railway Association have been removed from No. 24 Park place, New York City, to the new fireproof structure known as the Underwood Building, located at the corner of Church and Vesey streets (No. 75 Church street, with entrance at No. 30 Vesey street). The committee rooms are located upon the eighteenth floor. The office of the general agent is upon this floor and also all the offices of the bureau of explosives. The offices of the general secretary and treasurer and of the assistant general secretary and assistant treasurer are located upon the sixteenth floor.

The Vera Cruz Terminal Company, which is constructing terminals and port facilities at Vera Cruz at a cost of $6,000,000, is receiving a large amount of new rolling stock from the United States. It includes standard gauge flat cars, coal cars and switch engines. Thirty box cars are also on their way.

Test of Simple 4-4-2 Type Locomotive on the Altoona Testing Plant

PENNSYLVANIA RAILROAD.

Bulletin Number Five issued by the Pennsylvania Railroad contains the complete data obtained from a test of P. R. R. class E2a locomotive No. 5266 presented in a style uniform with that used in publishing the results of the tests at St. Louis. It also contains a comparison of the results given by this locomotive and New York Central Cole balance compound No. 3000 tested at St. Louis. It is principally this section of the bulletin that is given below.

The original program of tests that was planned by the Pennsylvania Railroad Company to be made on the Locomotive Testing plant at St. Louis, in 1904, included tests of one of the company's simple passenger locomotives of the Atlantic type with D valves and a locomotive of this type was prepared and held in readiness for the tests, but as the time at St Louis was not sufficient, these tests could not be carried out.

That tests of a simple two-cylinder passenger locomotive, made under the same conditions as were maintained in the tests of the four-cylinder balanced compound passenger locomotives, would be of particular interest has been apparent.

Upon the completion of the Testing Plant at its permanent location at Altoona this locomotive was placed upon it, and the results of such a series of tests as was formerly contemplated are now available.

This locomotive, No. 5266, has been tested by the same methods and under as nearly as possibie the same conditions, using the same kind of coal as with the locomotives tested at St. Louis, so that comparisons are possible with these former tests. As the methods used in testing are given in detail in the report of the St. Louis tests, no extended description of them will be given here.

Description of the Locomotive.

Locomotive No. 5266 is of the Atlantic type with two simple cylinders and is nown as the "E2a" class. It is identical in all respects with the other locomotives of its class and may be taken as representative of a large class of passenger locomotives used on the Pennsylvania Railroad in regular service.

The locomotive was built in 1904 and has seen considerable service since that time. In preparing it for the tests it was taken into the shop and the boiler thoroughly cleaned and new tubes put in. New tires were put on the driving wheels to bring them up to the regular diameter of 80 inches. The machinery was thoroughly overhauled and put in good repair. The cylinders were found to be smooth and they were not rebored. The locomotive was then placed upon the plant and run for some time to get the bearing surfaces in good condition before beginning the tests.

Before the tests were completed the front driving wheel tires had become flat in one place, due, probably, to a soft place in the tire, and the locomotive was removed from the plant and the tires of the driving wheels turned.

The maximum calculated tractive effort at starting is 22,500 pounds with 80 per cent. of the boiler pressure available as mean effective pressure in the cylinders. This is equal to 136.6 pounds per pound of mean effective pressure in the cylinders.

The ratio of weight on drivers to the calculated maximum tractive effort is 4.9 to 1.

Soon after the tests were started it was found that with the damper in the ash-pan open the air inlet was not sufficiently large for tests of heavy load and the inlet area was increased by cutting holes in the ash-pan sides, so that the area of inlet for air was increased from 2.3 square feet to 6.3 square feet. This latter area was found to give not more than seven-tenths of an inch of water vacuum at full load tests.

It is probable that the area of opening in the ash-pan that is required on the Testing Plant, where the locomotive is stationary, is in excess of what would be necessary to give similar draught conditions where the locomotive is in service on the road, though data is not at hand to determine this.

The coal used in the tests of No. 5266 was the Scalp Level coal as used in the tests at St Louis. The average analyses for the two series of tests are given in the table in the next column.

The conditions under which the tests were made were selected in the following manner: The reverse lever latch was placed in the notch which would give the least possible cut-off in the cylinders, and with fully opened throttle and constant speed a test was run. Then the reverse lever was advanced to the next notch, giving a longer cut-off and another test run. This increase of cut-off was continued until at this speed the boiler would fail to supply steam at approximately working pressure. This process was then repeated for the next higher speed. Thus the tests show the performance of the locomotive for almost its whole range of action. The higher power tests at each speed

ANALYSIS OF COAL

	St. Louis Tests	Teeth of No. 5266 at Altoona.
Fixed Carbon	75.85 per cent.	76.25 per cent.
Volatile combustible	16.25 " "	16.13 " "
Moisture	.9 " "	1.60 " "
Ash	7.00 " "	6.02 " "
	100.00 " "	100.00 " "
Sulphur determined separately	.90 " "	.94 " "
B.t.u. per pound of coal	15025	15143

showing, with certain exceptions, the power that the locomotive is capable of delivering for a considerable length of time, such as two or three hours or the time required for a run over a 100-mile division of road.

This method of testing the locomotive under conditions which could be sustained for a considerable time, while it is the only fair method, does not, of course, give the much higher power that could be shown for a test of short duration, where the reserve power of a boiler full of heated water is drawn upon for a short time without using the injector to keep up the supply. It will be noted that in all of the tests that the injector was in operation practically all of the time of the test.

It has been the custom in locomotive tests to obtain a certain fixed evaporation for each square foot of heating surface or a certain quantity of coal burned per square foot of grate surface before ending the test, so that the total quantities would be approximately equal for tests at either light or heavy power.

While it cannot be said that any fixed method was rigidly adhered to in these tests, an endeavor was made to obtain an evaporation of 30 pounds of water for each square foot of heating surface or a total of approximately 70,000 pounds, though no tests were made of more than three hours' duration. At speeds of 240 and 280 revolutions per minute many difficulties arise that limit the possibility of making successful tests, so rather than incur the risk of having to stop the locomotive with a test uncompleted, the time of these high speed tests was reduced to an hour or an hour and a half. As data throughout the full range of the boiler capacity can be determined at the intermediate speeds, there is little gained by running these high speed tests longer than is required to obtain enough readings to determine the performance of the engines of the locomotive and the draw-bar pull.

Comparison of Compound and Simple.

Of the passenger locomotives tested at St. Louis in 1904, the New York Central locomotive, No. 3000, resembled P. R. R. locomotive No. 5266 in general dimensions, weight and class of service for which it was designed. It was, however, a four-cylinder balanced compound, while the 5266 is a simple locomotive.

In order to show a comparison of the results obtained on a simple and a compound locomotive, the following diagrams have been prepared from the results of tests on these two locomotives. Before taking up the discussion of these diagrams, however, some of the principal dimensions of the locomotives are given in parallel columns in order to show in what particulars they differ.

	N. Y. C. R. R. No. 3000	P. R. R. No. 5266
Total weight of locomotive working order, lbs.	200,000	184.167
Weight on drivers, locomotive, working order, lbs.	110,000	110,001
Cylinders, diameter and stroke, inches	15½ & 26 x 26	20½ x 26
Driving wheels, diameter, inches	79	80
Boiler, diameter, inches	72¼	67
Tubes, number	390	315
" diameter, inches	2	2
" length, inches	191.29	179.78
Heating surface, firebox (fire side) sq. ft.	202.83	156.86
Heating surface, tubes (fire side) sq. ft.	2,848.36	2,162.4
Heating surface, total (fire side) sq. ft.	3,051.19	2,319.26
Grate surface, sq. ft.	49.9	55.5
Ratio heating surface to grate area	61.10	41.79
Boiler volume, cu. ft. steam space	77.41	109.9
Boiler volume, cu. ft. water space	331.66	338.[illegible]

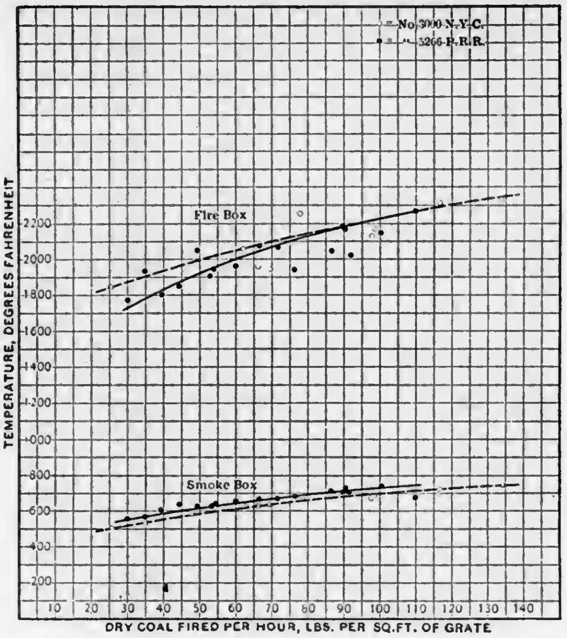


FIG. 1.

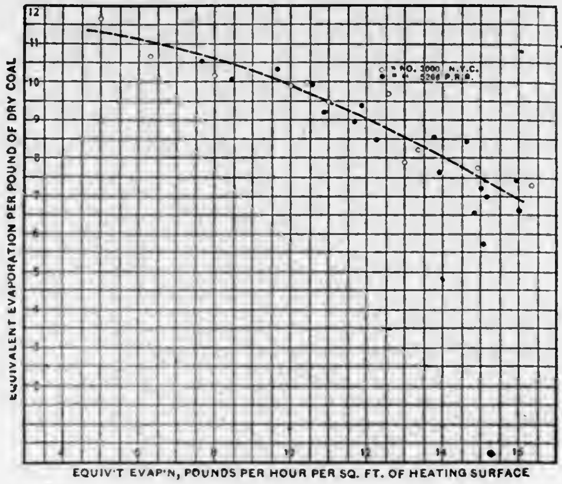


FIG. 2.

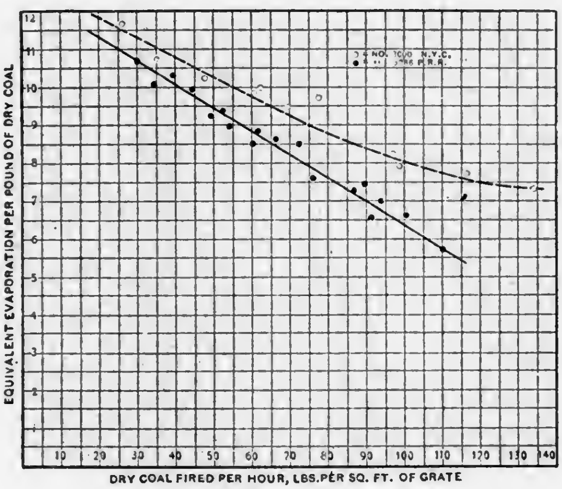


FIG. 3.

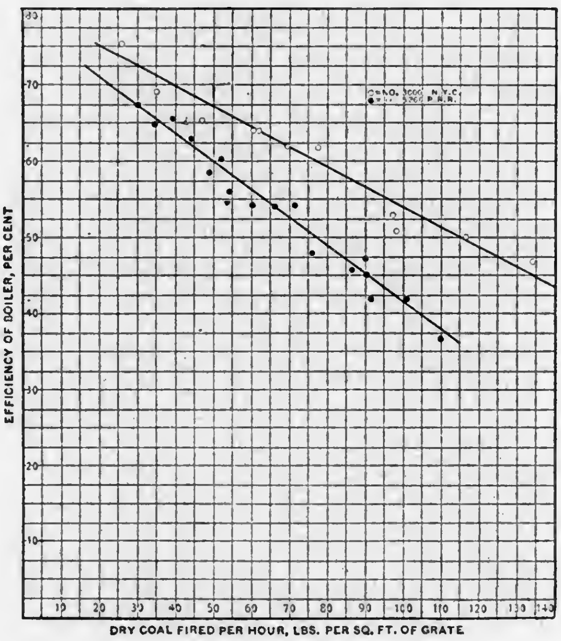


FIG. 4.

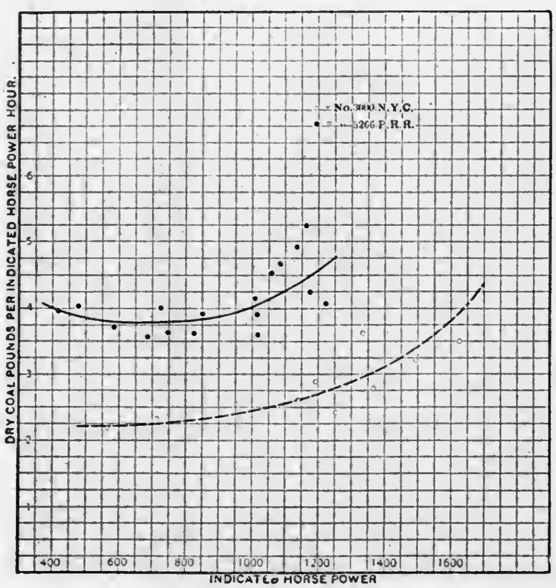


FIG. 6.

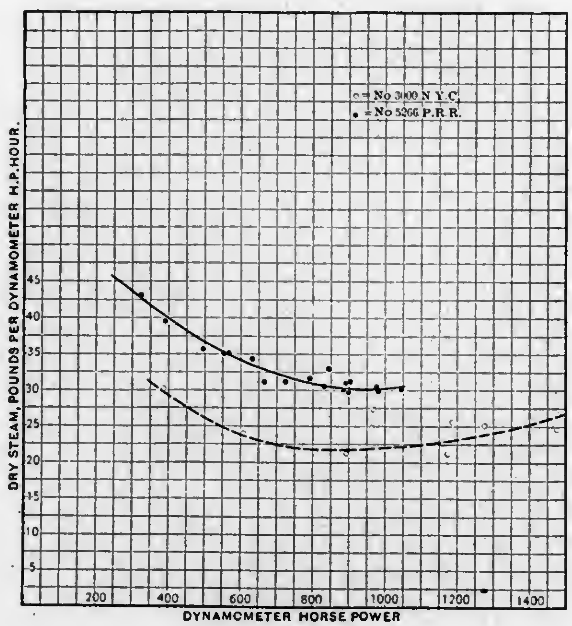


FIG. 7.

BOILER PERFORMANCE.

The coal used was that from the Scalp Level mines of the Berwind-White Coal Mining Company, both for the 3000 at St. Louis and the 5266 at Altoona.

In Fig. 1, where the firebox and smokebox temperatures are plotted, the differences between the two locomotives are small. The 3000 had a brick arch in the firebox, but no difference in firebox temperature is evident as due to this cause. The smokebox temperature of the 3000, which had a greater length of tube than the 5266, is shown to be lower throughout the tests, indicating that this greater tube length absorbed a larger part of the heat in the gases of combustion than the shorter tubes of the 5266.

In Fig. 2, where the equivalent evaporation per pound of dry coal is given for different rates of evaporation per square foot of heating surface, no difference is found between the two boilers. In other words, the efficiency of a square foot of heating surface in the boiler of 5266 is the same as the efficiency of a square foot of heating surface in the boiler of No. 3000, and this is true for all rates of evaporation.

For two boilers so similar in general type this is to be expected, as there is no reason to suppose that the heating surfaces of the two boilers will have materially different rates of heat transmission to the water when the steel plates are clean, as in the case of these two boilers. When, however, the equivalent evaporation per pound of coal is plotted according to the rate of combustion as in Fig. 3, the advantage of the larger heating surface per foot of grate in the 3000 is at once apparent, and this advantage of the 3000 in economical evaporation is maintained throughout the full range of steam delivery of the two boilers. The highest equivalent evaporation per square foot of heating surface is nearly the same for each boiler, being 16.34 pounds per hour in the case of the 3000 and 16.03 pounds for the 5266. With the boiler of No. 3000 the greatest loss of heat due to the presence of carbon monoxide in the products of combustion, or, in other words, the greatest loss due to poor combustion was but 1¼ per cent., and in only one other test was it as much as 1 per cent. In the case of the 5266, the losses, while in all cases comparatively small, are in one test 9.13 per cent., and in two others 6.06 per cent. and 7.3 per cent. The very perfect combustion shown by the 3000 is, in all probability, due to the brick arch in the firebox of this locomotive. There was no arch in the 5266.

The 3000 was fitted with smokebox deflectors or diaphragms which made the smokebox completely self-cleaning, while the 5266 did not have a self-cleaning front, and this was one of the limiting factors in maximum evaporation obtained with long cut-offs, due to the accumulation of cinders in the front end, which interfered with the draft, and, consequently, the steaming capacity. The results from the action of the two smokeboxes are shown in Fig. 5½.

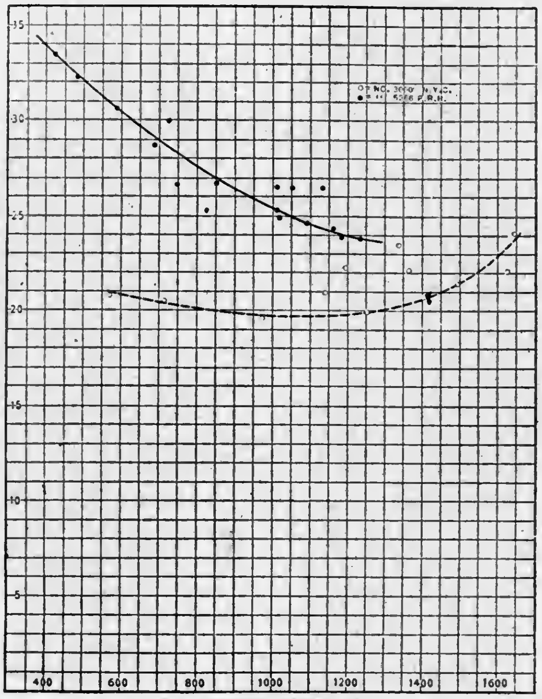


FIG. 5.

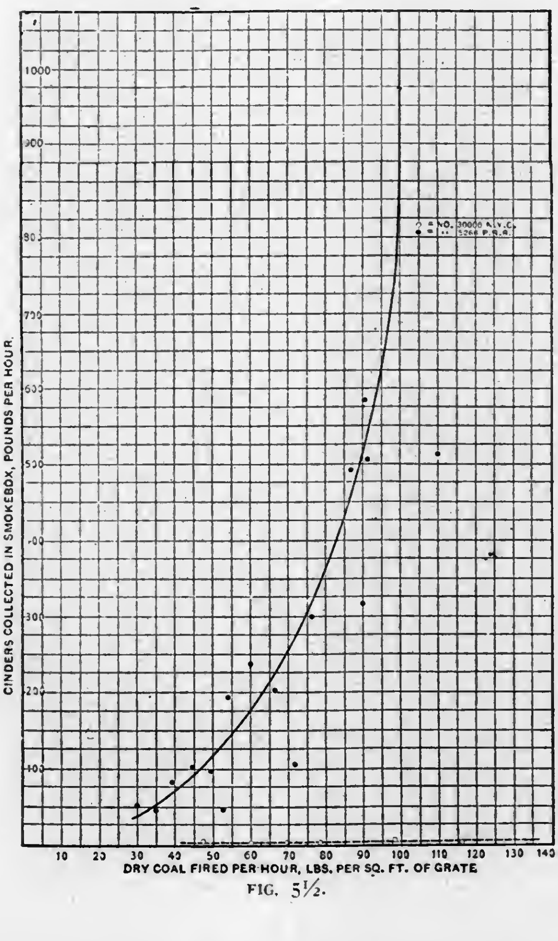


FIG. 5½.

ENGINE PERFORMANCE.

In Fig. 5 the well-established fact that the engines of a compound locomotive within limits operate on less steam per unit of power than the engines of a simple locomotive, is shown.

The diagram shows very clearly another fact that is not so generally recognized, and that is that the difference in the water rate or steam per horsepower hour is not a constant difference expressable as a certain definite percentage of saving. When each of the locomotives is developing 600 horsepower, there is a difference in the steam per horsepower of about 9.7 pounds, or a saving of 31.8 per cent., while at 1,300 horsepower the saving is but 3.5 pounds, or 14.9 per cent.

The two curves show that the water rates of the two locomotives would, perhaps, meet at about 1,600 horsepower were it possible to drive the 5266 to such a point, and as the high horsepowers were obtained, as a rule, at the higher speeds, the curves would indicate that the simple locomotive is working most economically at its highest speeds, while the reverse is true of the compound.

It will be remembered that in the case of the simple and compound freight locomotives tested at St. Louis the conclusions arrived at in regard to the steam consumption were as follows: "In general the steam consumption of the simple engines decreased with increase in speed, while that of the compounds increased, which would lead to the conclusion that the steam distribution of the compounds was less satisfactory at high speeds than that of the simple." The maximum horsepower developed by the 3000 was 1,641, while the maximum for the 5266 was 1,281.

In Fig. 2 we have seen that the evaporation per pound of coal decreases as the output of the boiler in steam increases, and this decrease explains the difference in the appearance of the curves in Figs. 5 and 6. It would appear at first sight as though the curves for coal for indicated horsepower hour should follow the same law as do the curves for steam, and this would be the case if it were not for the fact that as the output of the boiler increases, it is at the expense of a greater and greater quantity of coal per pound of water evaporated.

LOCOMOTIVE PERFORMANCE.

In Fig. 10 is shown the dry steam used by the locomotives at different indicated horsepowers. The 3000, compound, requires at all powers less steam than the 5266, simple locomotive, but as the limit of power is approached by the compound the steam rate advances more rapidly than would apparently be the case with a simple locomotive. This is only another way of showing that the advantage of compounding may not be realized at high speeds, as was developed in the discussion of Fig. 5, as judged by the two locomotives under discussion.

One of the most significant results of this comparison of a simple with a compound locomotive is the large increase in horsepower and draw-bar pull that can be realized from compounding without any increase in the boiler capacity. This is a very important advantage aside from all considerations of economy in the use of fuel.

Let us assume that the boiler of each locomotive will deliver

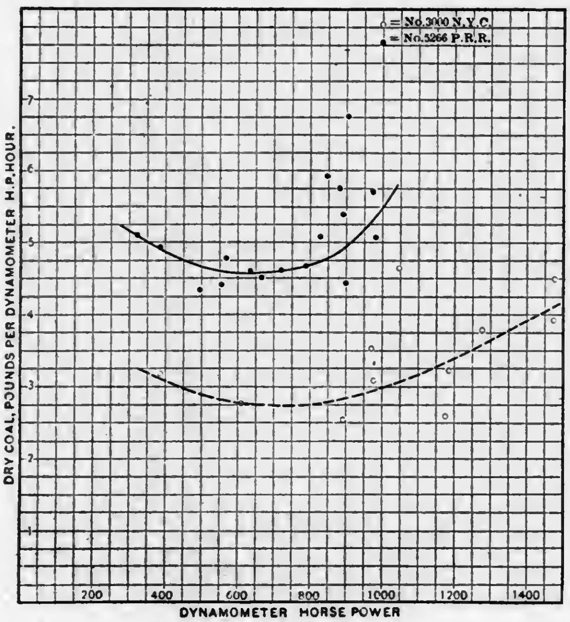


FIG. 8.

30,000 pounds of dry steam per hour to the engines. With this weight of steam the simple locomotive, No. 5266, will develop 1,200 indicated horsepower, while the compound, No. 3000, will develop 1,400 indicated horsepower. To show what this will

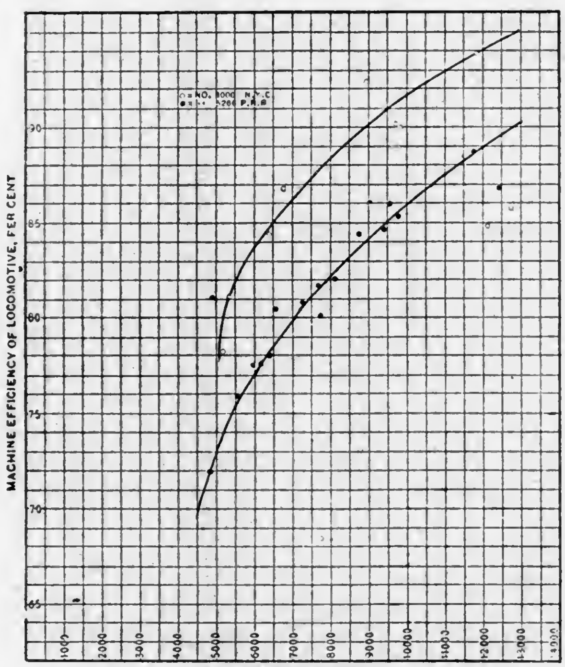


FIG. 9.

mean in increased draw-bar pull, due to compounding at several speeds, the following table has been arranged:.

Comparative Performance.

Locomotive.	Type.	Machine Efficiency.	Indicated Horse-power.	Dynamometer Horse-power.	Draw-Bar Pull.	Increase in Draw-Bar Pull From Compounding.
At 40 Miles Per Hour, Using 30,000 Pounds of Water Per Hour.						
5266	4-4-2 Simple	86	1200	1032	9674	
3000	4-4-2 Compound	86	1400	1204	11287	+1613
At 50 Miles Per Hour, Using 30,000 Pounds of Water Per Hour.						
5266	Simple	79	1200	948	7110	
3000	Compound	79	1400	1106	8294	+1184
At 60 Miles Per Hour, Using 30,000 Pounds of Water Per Hour.						
5266	Simple	77	1200	924	5775	
3000	Compound	77	1400	1078	6737	+962

The above table shows what might be expected in increased power if the cylinders of locomotive No. 3000 were to be applied to locomotive No. 5266.

The probable result in fuel saving with this combination of the compound cylinders and the boiler of No. 5266, working as

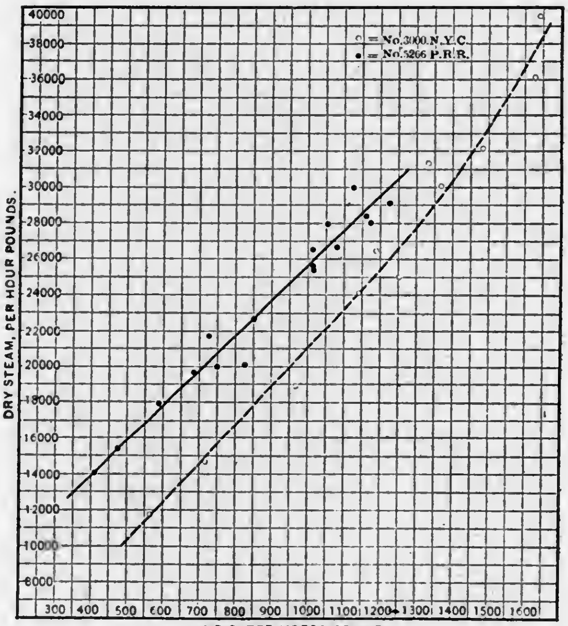


FIG. 10.

before at about its maximum rate of evaporation, that is, delivering 30,000 pounds of dry steam per hour, will be as shown in the following table:

Coal Per Dynamometer Horse-Power Hour for Locomotive 5266, With Its Present Simple Cylinders and the Results to be Expected If the Present Boiler Were to be Fitted With Compound Cylinders Similar to those on No. 3000:

Assumed Evaporation Lbs. of Dry Steam Per Hour.	Corresponding Dry Coal Burned Per Hour, Pounds.	Dynamometer Horse Power Locomotive With. Simple Cylinders.	Dynamometer Horse Power Locomotive With. Compound Cylinders.	Speed, Miles Per Hour.	Dry Coal Per Dynamometer H. P. Hour. Locomotive With Simple Cylinders	Dry Coal Per Dynamometer H. P. Hour. Same Boiler With Compound Cylinders	Difference in Favor of Compound Cylinders, Pounds of Coal.	Saving Expressed as a Percentage.
30,000	4983	1032	1204	40	4.82	4.13	.69	14.3
30,000	4983	948	1106	50	5.25	4.51	.74	14.1
30,000	4983	924	1078	60	5.39	4.62	.77	14.3

It will be noted that this percentage of saving agrees closely with that observed under engine performance. It is also the saving at a point where the simple locomotive is at its best, as before noted, namely, at its maximum horsepower. Other lower rates of evaporation might be selected where percentages of saving would be much higher.

Frank Thomson Scholarships.—Robert Francis Hohman, of Fort Wayne, Ind., and John James Caldwell, of New Florence, Penn., have been announced as the successful candidates for the Frank Thomson Scholarships. At present there are eight holders of these scholarships, which is the number maintained out of a fund endowed in the sum of $120,000 by the three children of the late Frank Thomson, former president of the Pennsylvania Railroad, as a memorial to their father. Each year two scholarships, each amounting to $600 annually, are awarded on competitive examination to sons of employees of the Pennsylvania Railroad System.

SEVENTY FOOT GAS-ELECTRIC MOTOR CARS

ST. LOUIS & SAN FRANCISCO R. R.

The General Electric Company has just delivered to the 'Frisco Lines six motor cars which represent the latest development of the gasolene-electric type of self-propelled car.

These cars are of all-steel construction, 70 ft. 6¾ in. long, and have a maximum seating capacity of 86 persons or a nominal seating cajacity with two persons each seat of 62, in addition to a baggage compartment and the cab in the pointed front end. They weigh about 96,000 lbs. complete.

The cars are designed with special reference to light construction with adequate strength. The interior arrangement is designed to meet the Southern traffic conditions, providing separate accommodations and entrances for white and colored passengers. The observation platform is unusually wide and is equipped with trap doors and brass railings, presenting a most attractive appearance. The windows are large, fitted with plate glass, and so arranged that they may be raised to a height of 17 in., allowing an unobstructed view. These are equipped with safety sash locks, anti-rattlers and weather strips. Each window is provided with a large, fine mesh-copper, automatic screen running on metal guides. The window curtains are of pantasote of neat design and equipped with pinch handle fixtures.

The interior is finished in a high grade of mahogany with paneling on the bulkheads. Each of the three compartments is provided with a saloon, drinking fountain and electric fans. The seats are of unusual length, providing commodious accommodations for two persons, and are amply large enough to seat three. These are of the stationary back type, with high grade spring construction in both seat and back cushions. Ventilation is provided through large suction ventilators located on the center of the roof, the openings protected by neat ceiling register plates. The entire car, including platforms and vestibules, is lighted by electricity. The partition between the baggage room and negro compartment is movable and may be arranged to give the baggage compartment a length of 8 ft. or 10 ft. 5 in., to suit traffic requirements.

The framework of the car is entirely of steel, the under framing consisting of two I beams for center sills, and two channels for outside sills, with truss rods for reinforcement. The center sills are continuous and provide supports for the rear platform. The outside sheathing is of steel riveted to the posts, which together with the carlines are of steel tees. The roof is of galvanized iron plates riveted to the carlines, except under the radiators, where it is of copper with well soldered joints. The floors in the passenger compartments are of two thicknesses with a heavy layer of felt between. There is also an additional lining of sheet iron beneath the lower wood floor.

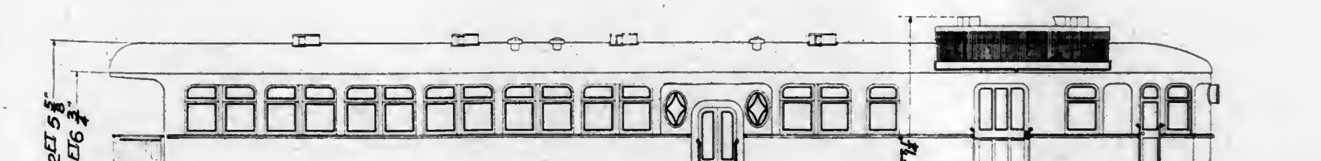
SEVENTY-FOOT GAS-ELECTRIC MOTOR CAR WITH BOTH END AND CENTER ENTRANCE.

POWER PLANT EQUIPMENT.

The power equipment is located in the cab at the front end of the car, and consists of the following:

A main gas engine generating set, consisting of an eight-cylinder gasolene engine with direct connected generator; an auxiliary gas engine generating set with integral air pump and lighting generator; equipment for motor control; air and hand brake systems; pneumatic bell ringer; sander; warning and signal whistles and a coal fired hot water heater. The motors are mounted one upon each axle of the front truck.

The main gas engine is of the eight-cylinder, four-stroke cycle "V" type. The generator magnet frame is bolted to the frame of the gas engine, which rests upon the floor of the car with cushion support. The speed of the engine is adjusted by a



PLAN AND ELEVATION OF FRISCO MOTOR CAR.

One of the most significant results of this comparison of a simple with a compound locomotive is the large increase in horsepower and draw-bar pull that can be realized from compounding without any increase in the boiler capacity. This is a very important advantage aside from all considerations of economy in the use of fuel.

Let us assume that the boiler of each locomotive will deliver 30,000 pounds of dry steam per hour to the engines. With this weight of steam the simple locomotive, No. 5266, will develop 1,200 indicated horsepower, while the compound, No. 3000, will develop 1,400 indicated horsepower. To show what this will mean in increased draw bar pull due to compounding at several speeds, the following table has been arranged:

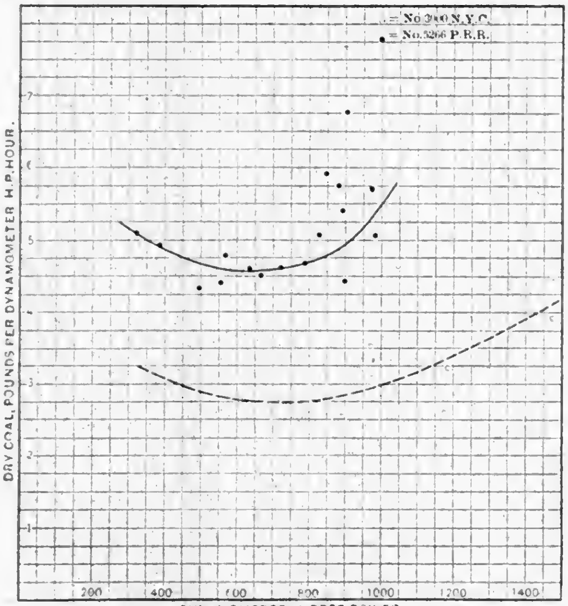


FIG. 8.

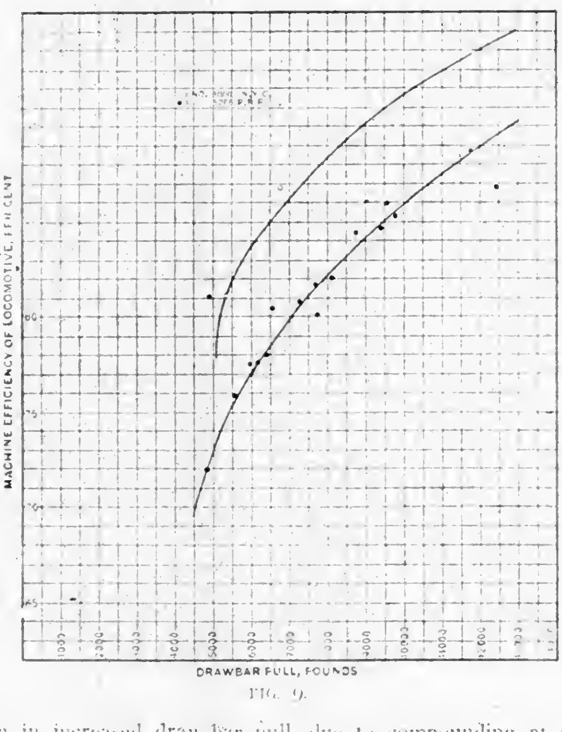


FIG. 9.

COMPARATIVE PERFORMANCE.

Locomotive.	Type	Machine Efficiency.	Indicated Horsepower.	Dynamometer Horsepower.	Draw-Bar Pull.	Increase in Draw-Bar Pull From Compounding.
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The above table shows what might be expected in increased power if the cylinders of locomotive No. 3000 were to be applied to locomotive No. 5266.

The probable result in fuel saving with this combination of the compound cylinders and the boiler of No. 5266, working as before at about its maximum rate of evaporation, that is, delivering 30,000 pounds of dry steam per hour, will be as shown in the following table:

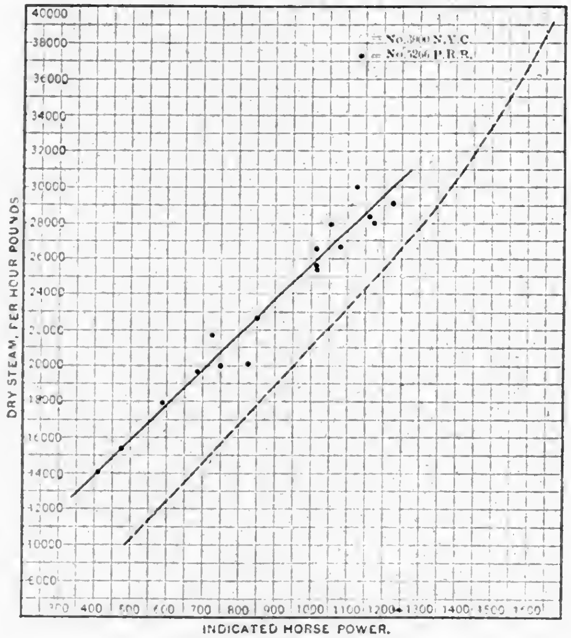

FIG. 10.

COAL PER DYNAMOMETER HORSE-POWER HOUR FOR LOCOMOTIVE 5266, WITH ITS PRESENT SIMPLE CYLINDERS AND THE RESULTS TO BE EXPECTED IF THE PRESENT BOILER WERE TO BE FITTED WITH COMPOUND CYLINDERS SIMILAR TO THOSE ON No. 3000:

Assumed Evaporation Lbs. of Dry Steam Per Hour.	Corresponding Dry Coal Burned Per Hour. Pounds.	Dynamometer Horse Power Locomotive With. Simple Cylinders.	Dynamometer Horse Power Locomotive With. Compound Cylinders.	Speed, Miles Per Hour.	Dry Coal Per Dynamometer H. P. Hour. Locomotive With Simple Cylinders	Dry Coal Per Dynamometer H. P. Hour. Same Boiler With Compound Cylinders	Difference in Favor of Compound Cylinders Pounds of Coal.	Saving Expressed as a Percentage.
30,000	4983	1032	1204	40	4.82	4.13	.69	14.3
30,000	4983	948	1106	50	5.25	4.51	.74	14.1
30,000	4983	924	1078	60	5.39	4.62	.77	14.3

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SEVENTY FOOT GAS-ELECTRIC MOTOR CARS

ST. LOUIS & SAN FRANCISCO R. R.

The General Electric Company has just delivered to the 'Frisco ...es six motor cars which represent the latest development of ... gasolene-electric type of self-propelled car.

These cars are of all-steel construction, 70 ft. 6¾ in. long, and ...ve a maximum seating capacity of 86 persons or a nominal ...ting capacity with two persons each seat of 62, in addition ...a baggage compartment and the cab in the pointed front end. ...ey weigh about 96,000 lbs. complete.

The cars are designed with special reference to light con...uction with adequate strength. The interior arrangement is ...signed to meet the Southern traffic conditions, providing sep...ate accommodations and entrances for white and colored pas...ngers. The observation platform is unusually wide and is ...uipped with trap doors and brass railings, presenting a most ...ttractive appearance. The windows are large, fitted with plate ...ass, and so arranged that they may be raised to a height of 17 ..., allowing an unobstructed view. These are equipped with ...fety sash locks, anti-rattlers and weather strips. Each window ... provided with a large, fine mesh-copper, automatic screen ...nning on metal guides. The window curtains are of pantasote ... neat design and equipped with pinch handle fixtures.

The interior is finished in a high grade of mahogany with ...neling on the bulkheads. Each of the three compartments is ...rovided with a saloon, drinking fountain and electric fans. The seats are of unusual length, providing commodious accom...odations for two persons, and are amply large enough to seat ...ree. These are of the stationary back type, with high grade ...ring construction in both seat and back cushions. Ventilation is provided through large suction ventilators located on the center of the roof, the openings protected by neat ceiling register plates. The entire car, including platforms and vestibules, is lighted by electricity. The partition between the baggage room and negro compartment is movable and may be arranged to give the baggage compartment a length of 8 ft., or 10 ft. 5 in., to suit traffic requirements.

The framework of the car is entirely of steel, the under framing consisting of two I beams for center sills, and two channels for outside sills, with truss rods for reinforcement. The center sills are continuous and provide supports for the rear platform. The outside sheathing is of steel riveted to the posts, which together with the carlines are of steel tees. The roof is of galvanized iron plates riveted to the carlines, except under the radiators, where it is of copper with well soldered joints. The floors in the passenger compartments are of two thicknesses with a heavy layer of felt between. There is also an additional lining of sheet iron beneath the lower wood floor.

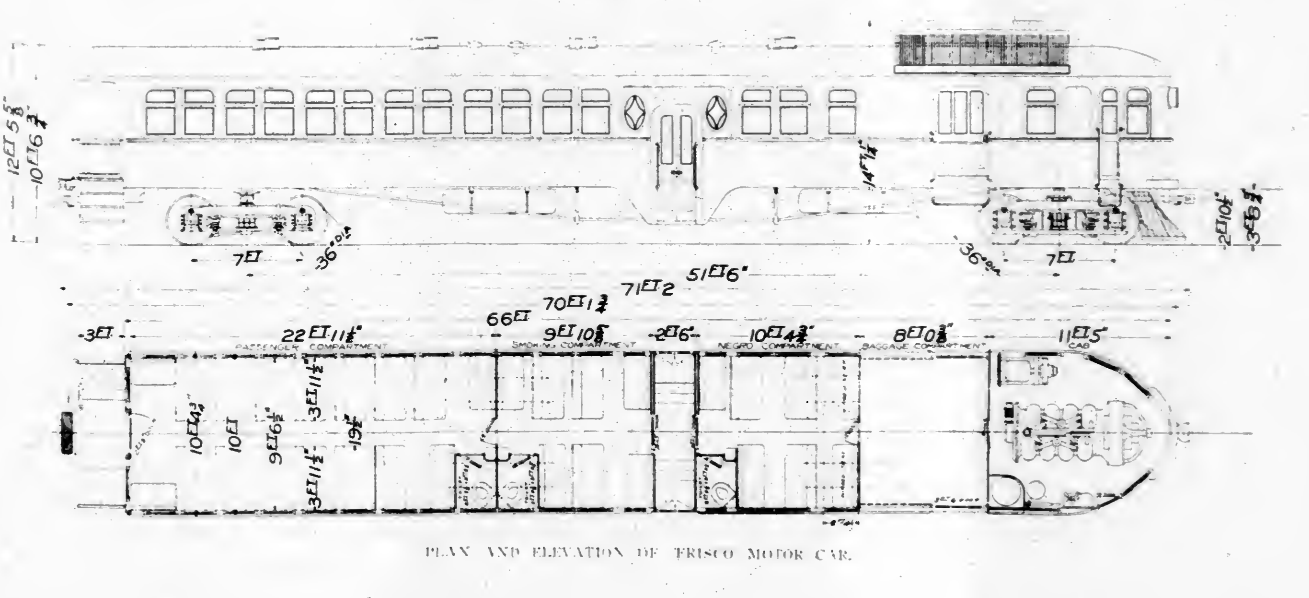
SEVENTY-FOOT GAS-ELECTRIC MOTOR CAR WITH BOTH END AND CENTER ENTRANCE.

POWER PLANT EQUIPMENT.

The power equipment is located in the cab at the front end of the car, and consists of the following:

A main gas engine generating set, consisting of an eight-cylinder gasolene engine with direct connected generator; an auxiliary gas engine generating set with integral air pump and lighting generator; equipment for motor control; air and hand brake systems; pneumatic bell ringer; sander; warning and signal whistles and a coal fired hot water heater. The motors are mounted one upon each axle of the front truck.

The main gas engine is of the eight cylinder, four-stroke cycle "V" type. The generator magnet frame is bolted to the frame of the gas engine, which rests upon the floor of the car with cushion support. The speed of the engine is adjusted by a



PLAN AND ELEVATION OF 'FRISCO MOTOR CAR.

throttle, the normal speed being 550 r. p. m.; the base and crank case are of cast iron with suitable hand holes provided in the base for the inspection of the main bearing cranks. The cylinders, 8 x 10 in., are of close grain gray cast iron with water jackets integral.

There are two cam shafts, one on each side of the engine, and these are made from forged rolled steel shafting, while the cams are of high carbon steel, oil tempered. The cam shafts are located in tunnels with covers so arranged that they may be easily removed. The ignition system consists of two low tension Bosch magnetos, one for each side of the engine, with Bosch magnetic spark plugs. All wires from the magnetos to the spark plugs are enclosed in a brass hand rail, so that there are no loose or exposed wires. The engine is lubricated by oil under pressure delivered by a plunger pump direct driven from the crank shaft. Gasolene is delivered by a direct driven pump to the carburetors, which are of the automatic constant level type.

The engine cooling system consists of thermo-siphon circulation of the water in radiators of fine tube type, which are located on the roof of the car with flexible metal tube connections from the engine to the radiator headers. The engine is started by air stored in tanks beneath the car, which may be charged from the auxiliary gas engine set or from the main compressor located at the rear end of the main engine and direct driven from the crankshaft. The main compressor has a capacity of 22½ cu. ft. of free air per minute.

The main generator is of the commutating pole type designed specially for heavy traffic work. The entire machine is enclosed within a three arm bracket which supports the outer bearing of the generator armature.

The motors are of the box frame, commutating pole, oil lubricated type, known as standard General Electric 205-600 volt 100 h.p. railway motors. Current to the motors is supplied through cables in conduit from the generator.

The auxiliary gas engine set consists of a three-cylinder, four stroke cycle, vertical type gas engine, the center cylinder being used as an air compressor. The lighting generator is direct connected to this. The construction of this engine is similar to that of the main engine, with the exception that the cylinders are of the tee head type, having two cam shafts. Lubrication is of the constant level splash system, the level and circulation being maintained by a paddle wheel pump. A fly ball gear driven governor acting on a butterfly valve in the intake pipe is used to maintain a constant speed of 600 r. p. m. The cooling system for this engine is the same as for the large engine. The air pump on this engine is capable of delivering 45 cu. ft. of free air per minute and will charge the tanks to a pressure of 90 lbs. in about 10 minutes. This pump is used to supply air for starting the main engine after it has been idle if pressure in the main reservoirs has gone down. The auxiliary gas engine is started by hand.

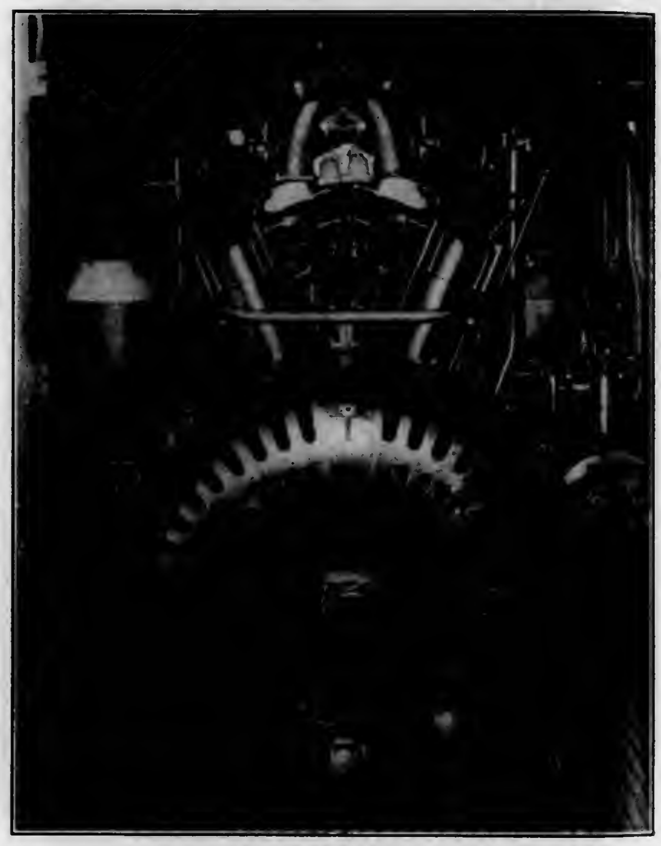
The operator's seat is at the right hand side of the cab beside a sliding window. All the control, air brake, and signal apparatus is conveniently located at this point and so arranged that the car and engine may be controlled without the operator leaving his seat.

One of the distinguishing features of these cars is the flexibility of control. Power is delivered to the motors from the main generator through a controller of a type similar in appearance to those used in trolley car practice. Concentric with the electrical controller handle, but above it, is an air starting throttle handle. This handle is so arranged that by pressing a lever, air for starting the engine may be admitted to the engine distributing valve at the same time opening the throttle. Provisions are made, however, so that the throttle may be opened only to a set distance to prevent the racing of the engine. The engine started the air pressure is cut off and the throttle opened wider. It is not possible to admit air again to the engine without returning to the initial point, thus closing the throttle. The direction of the car may be reversed in a manner similar to that employed on a trolley car, by the moving of the reversing handle, the gas engine always running in the same direction.

The brake system consists of straight and automatic air with auxiliary hand brakes, the handles, which are of the Lindstrom type, are located one in the cab convenient to the motor, and one on the rear platform. The air gauges are located on a panel immediately in front of the operator.

Electricity is used for lighting, power being supplied from the lighting generator driven by the auxiliary gas engine. There is a voltmeter on the panel together with the air gauges and a rheostat box is mounted on the wall of the cab, so that the operator may regulate the lighting voltage as desired. There are two circuits, one on each side of the car, for the passenger and baggage compartments, with an additional circuit for fan motors.

The car is heated by hot water either supplied from the gas engine jackets or from a coal fired Baker hot water heater located in the corner of the cab, which is fired from the baggage room. Provision is made so that hot water from the coal



POWER PLANT IN SEVENTY-FOOT GAS-ELECTRIC CAR.

heater may be circulated through the engine jackets and radiators to prevent freezing on cold nights or during layovers.

The gasolene storage tank is located beneath the baggage room. Gasolene is supplied to the tank through a filler on the outside of the car with suitable strainers and filters. There is in addition a vent pipe to the roof.

There are three air reservoirs located under the car and so arranged that the air taken from these reservoirs for starting the engine does not drain the brake reservoirs. There is also a reservoir for the signal and warning whistles.

The trucks are of the swing bolster type, the frames being of boiler plate steel with pedestal shoes of cast iron. The bolster springs are triple elliptic and equalizer springs triple coil. The wheels are 36 in. in diameter, with standard M. C. B. treads and flanges. Each truck has a wheel base of 7 ft., the total wheel base of the car being 58 ft. 6 in.

THE SCIENCE OF MANAGEMENT is in a very undeveloped state, but progress is being made and another generation or two will look back upon the methods of to-day as exceedingly crude.—*David Van Alstyne before the Congress of Technology, Boston.*

NEW DESIGN LOCOMOTIVE SAND BOX

The interesting sanding apparatus herewith illustrated has been patented by Samuel H. Dunning, until recently traveling representative of the American Locomotive Co. at Paterson, N. J., and has for its object to provide a practical arrangement which will be substantially proof against the sand clogging, and which will also be simple in construction and capable of being readily adapted to any locomotive.

In his specification Mr. Dunning points out that the sanding apparatus commonly in use requires constant attention in order to keep it in proper working order, principally because the conduits whereby the sand is led from the box are not only of small diameter, but of uniform dimension from end to end, and first tapers down to its smallest diameter, as at (i), and then expands, giving its lower portion (j) a flaring form; each leg may be provided with a removable cap (k) which permits access to its interior for the purpose of freeing it of clogging sand.

The section (c) has the flanges (l) which are so constructed that when the section (c) is arranged in proper position on the boiler, the flanges will lie squarely against the top, and will serve as a means for riveting the section to the boiler; the rivets being indicated at (m). The inside of the top part (g) of section (c) is formed with a longitudinal ridge (n) whose sides incline downwardly, and merge into the inside surface on which the sand might remain when otherwise free to descend. The section (d) has its lower edge (o) fitting into a rabbet (p) formed in the top of section (c); similarly, this section has its upper edge

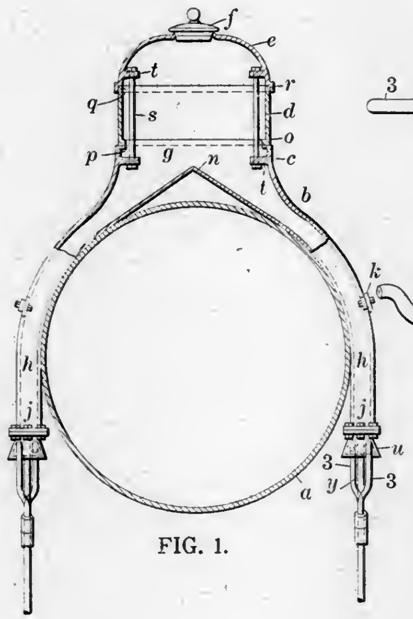


FIG. 1.

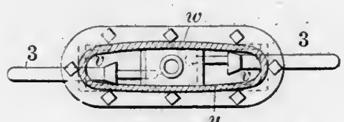


FIG. 4.

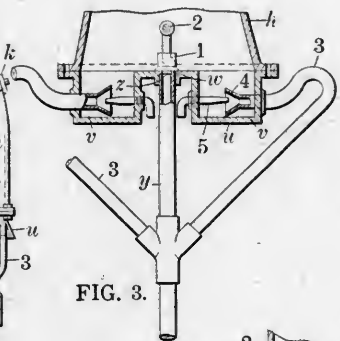


FIG. 3.

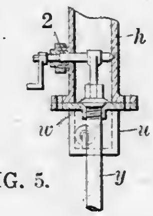


FIG. 5.

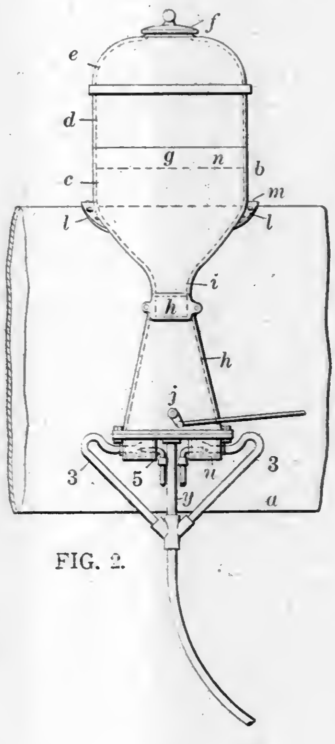


FIG. 2.

so that, even if the sand be perfectly dry, it packs and clogs under the vibration of the engine. Attention is also directed to the fact that when it becomes necessary to have access to the interior of sand boxes, as ordinarily arranged, for cleaning or repairs, much time and labor must be expended on work which is entirely foreign to that primarily requiring attention.

The disadvantages of the present sanding apparatus have been borne prominently in mind in the new design, which is shown in the accompanying drawing in five different views, Figure 1 being a view in front elevation, partly in section; the boiler of a locomotive being shown in vertical section; Fig. 2 a view in side elevation of the improved sanding apparatus; Fig. 3 a vertical sectional view of the lower portion of one of the legs of the apparatus; and Figs. 4 and 5 views illustrating details.

The boiler of the locomotive is shown at (a); arranged on the boiler and straddling the same is a bifurcated box or casing (b) which may be described in detail as follows: It comprises three sections, (c), (d) and (e), the section (c) being the bifurcated portion of the box or casing, the section (d) its cylindrical or body portion, and the section (e) its dome or cover portion, the latter having the usual cap (f) which may be removed for the purpose of permitting the box or casing to be filled. The section (c) is substantially cylindrical in its top part (g), but in its bottom part it is formed as two tubular legs (h), each of which has preferably an elliptical cross-section, (q) fitting into a rabbet (r) formed in the top section (c). The three sections may be conveniently secured together by bolts (s) engaging the lugs (t) in the sections (c) and (e).

To the bottom of each leg of the section (c) is bolted a valve casing (u). The bottom wall of each leg opens into this valve casing, which comprises two compartments (v) separated by a horizontal wall (w) into which is tapped the pipe (y) which leads down to and discharges on the track in proper relation to one of the driving wheels. The port (z) formed at the upper end of this pipe is controlled by the manually operated slide valve (1) which moves on the wall (w) when actuated from the cab through its bell-crank lever (2), fulcrumed in leg (h) of the casing (b). This latter mechanism forms what is commonly known as the "hand sander." From the opposite walls of the compartments (v) lead the pipes (3) which connect with pipe (y), and into whose flaring upper ends (4) discharge the ejector-nozzles (5) which are suitably connected with the air supply, this mechanism forming what is known as a "pneumatic sander."

The operation of the apparatus will be clearly understood by those familiar with the art without description. It may be remarked, however, that the improved sander distinguishes from those at present in use and possesses certain advantages over them, which may be set forth as follows: Owing to the internal construction of the box or casing, the sand will stand free at all times from the highest level thereof clear to the valve cas-

throttle, the normal speed being 550 r. p. m.; the base and crank case are of cast iron with suitable hand holes provided in the base for the inspection of the main bearing cranks. The cylinders, 8 x 10 in., are of close grain gray cast iron with water jackets integral.

There are two cam shafts, one on each side of the engine, and these are made from forged rolled steel shafting, while the cams are of high carbon steel, oil tempered. The cam shafts are located in tunnels with covers so arranged that they may be easily removed. The ignition system consists of two low tension Bosch magnetos, one for each side of the engine, with Bosch magnetic spark plugs. All wires from the magnetos to the spark plugs are enclosed in a brass hand rail, so that there are no loose or exposed wires. The engine is lubricated by oil under pressure delivered by a plunger pump direct driven from the crank shaft. Gasolene is delivered by a direct driven pump to the carburetors, which are of the automatic constant level type.

The engine cooling system consists of thermo-siphon circulation of the water in radiators of fine tube type, which are located on the roof of the car with flexible metal tube connections from the engine to the radiator headers. The engine is started by air stored in tanks beneath the car, which may be charged from the auxiliary gas engine set or from the main compressor located at the rear end of the main engine and direct driven from the crankshaft. The main compressor has a capacity of 22½ cu. ft. of free air per minute.

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One of the distinguishing features of these cars is the flexibility of control. Power is delivered to the motors from the main generator through a controller of a type similar in appearance to those used in trolley car practice. Concentric with the electrical controller handle, but above it, is an air starting throttle handle. This handle is so arranged that by pressing a lever, air for starting the engine may be admitted to the engine distributing valve at the same time opening the throttle. Provisions are made, however, so that the throttle may be opened only to a set distance to prevent the racing of the engine. The engine started the air pressure is cut off and the throttle opened wider. It is not possible to admit air again to the engine without returning to the initial point, thus closing the throttle. The direction of the car may be reversed in a manner similar to that employed on a trolley car, by the moving of the reversing handle, the gas engine always running in the same direction.

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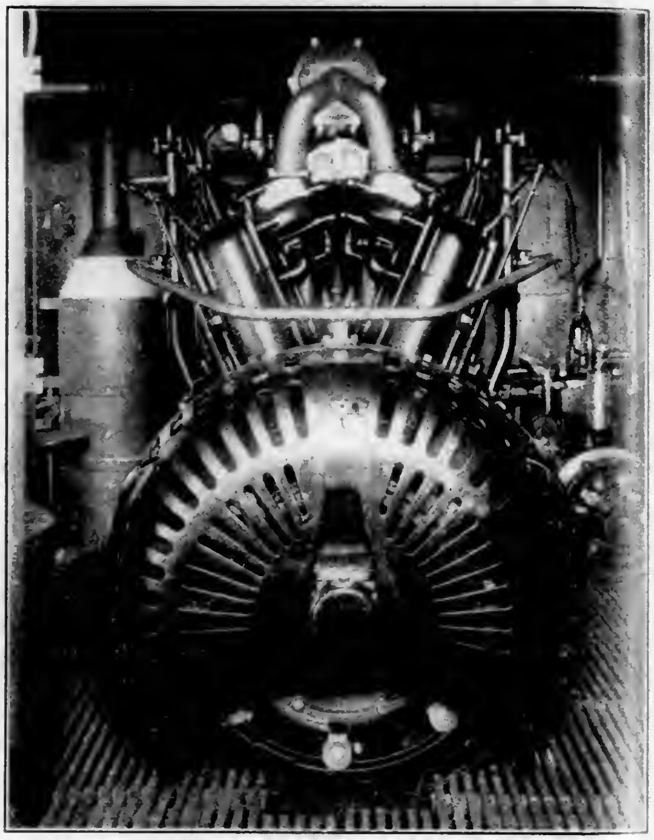

POWER PLANT IN SEVENTY-FOOT GAS-ELECTRIC CAR.

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The boiler of the locomotive is shown at (a); arranged on boiler and straddling the same is a bifurcated box or casing (b) which may be described in detail as follows: It comprises three sections, (c), (d) and (e), the section (c) being bifurcated portion of the box or casing, the section (d) its lindrical or body portion, and the section (e) its dome or ver portion, the latter having the usual cap (f) which may removed for the purpose of permitting the box or casing to illed. The section (c) is substantially cylindrical in its top art (g), but in its bottom part it is formed as two tubular gs (h), each of which has preferably an elliptical cross-section, and first tapers down to its smallest diameter, as at (i), and then expands, giving its lower portion (j) a flaring form; each leg may be provided with a removable cap (k) which permits access to its interior for the purpose of freeing it of clogging sand.

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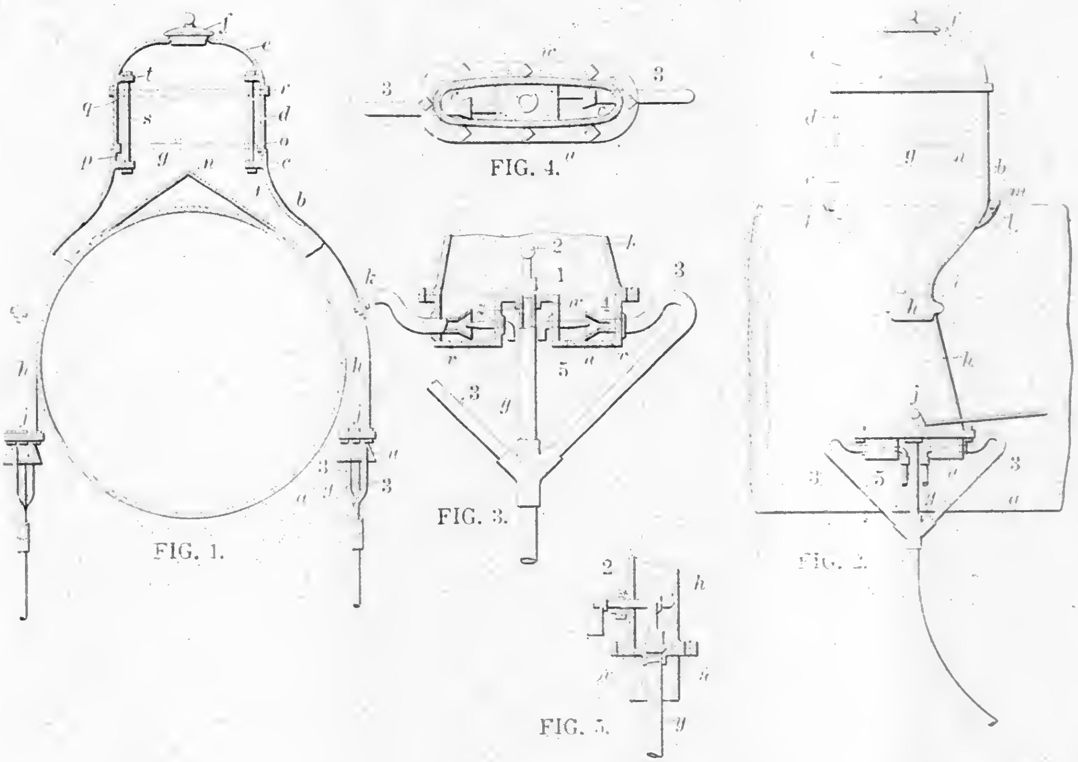

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5.

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To the bottom of each leg of the section (c) is bolted a valve casing (u). The bottom wall of each leg opens into this valve casing, which comprises two compartments (v) separated by a horizontal wall (w) into which is tapped the pipe (y) which leads down to and discharges on the track in proper relation to one of the driving wheels. The port (z) formed at the upper end of this pipe is controlled by the manually operated slide valve (1) which moves on the wall (w) when actuated from the cab through its bell-crank lever (2), fulcrumed in leg (h) of the casing (b). This latter mechanism forms what is commonly known as the "hand sander." From the opposite walls of the compartments (v) lead the pipes (3) which connect with pipe (y), and into whose flaring upper ends (4) discharge the ejector-nozzles (5) which are suitably connected with the air supply, this mechanism forming what is known as a "pneumatic sander."

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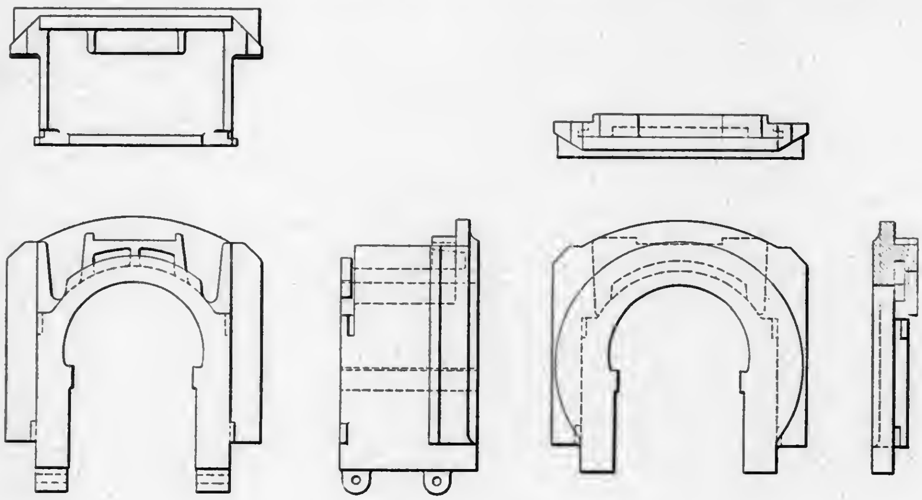
ing; it cannot "pile" in the portion of the casing which is directly over the boiler because of the ridge (n), and the hour-glass formation of each of its legs, taken with the fact that they are of ample inside proportions, will prevent the sand from clogging therein so long as it is free beneath them. The only parts of the mechanism which are likely to clog are those which depend from the valve casing, and the valve casing being readily detachable from the legs of the casing, it is only required to remove the valve casing in order to clear the pipes or such parts as may become clogged.

LOCOMOTIVE DRIVING BOX OF NEW DESIGN

The principal objection pertaining to the locomotive driving box as almost universally designed lies in its inaccessibility to repairs. Loose crown brasses are frequent, and are often allowed to run loose, as their removal implies dropping the wheels, which with modern power becomes quite a tedious and laborious operation, even when up-to-date facilities are at hand.



With the end in view to secure an acceptable and thoroughly practical substitute for the present arrangement, entirely free from the latter's objectionable features, H. Henrickson, one of the representatives of the Edward Smith Co., of Detroit, Mich., has placed on the market through the latter firm an entirely new design which is attracting considerable attention.

This new box is made in two parts, the one forming the main portion or body carrying the inside pedestal flange, and the bearing for the inside leg of the spring saddle, while the outside portion carries the outer pedestal flange and bearing. Each portion or body carrying the inside pedestal flange, and the other portion, forming one rigid box. There are three lugs on the main portion, and two on the outside one. The largest one is cast on the main body over the center of the axle, while the other two are placed two on each side, one at the top and the one at the bottom of each flange. With this distribution and the size given the lugs they are fully able to withstand all the stresses and strains to which they will be subjected, even in heavy service.

By removing the load from the top of the box, the outer section need only be raised vertically the height of the lugs, when it can be removed by moving the main body of the box toward the center of the engine, then rotating it around the axle and dropping it down. The inner section can then be removed from the center of the axle. It is claimed that the time required for moving each part of the box, after the weight has been lifted, averages one-half hour, and for replacing them the same time, making a total labor of one hour per box, or two hours per pair, as against from ten to fifteen hours per pair with the ordinary driving box.

The line drawing and photographs clearly indicate the construction. It will be noted that it is not a driving box with a removable brass as might appear at first glance. The box can be applied to any locomotive without any change in the shoes or wedges, and with a properly fit brass the latter should not come loose until worn out.

TOOL FOREMEN'S CONVENTION

The third annual convention of the American Railway Tool Foremen's Association was held at the Wellington Hotel, Chicago, July 11-13. W. H. Bray, N. Y., N. H. & H. R. R., New Haven, Conn., president of the association, presided.

Reports of committees and individual papers on the following subjects were presented for discussion: Tool room equipment, grinding wheels, standardization of steel, pneumatic tools and appliances, boiler shop tools, making of drills, dies for forging machines.

B. Hendrickson, C. & N. W., Chicago, presented the paper on "Tool Room Equipment," in which he stated that the proper location of the distributing tool room should be in the center of the main shop with a counter circumscribing the racks, and there should be openings for issuing tools opposite the racks holding each kind of tools which are most used. The tool room for repair and manufacture he recommended be located in a building adjoining the machine shop and presented a plan with list of machine tool equipment which he considered to be ideal. In discussing the arrangement of the machines, he stated that care should be taken to keep the grinders away from the lathes and other machines having exposed wearing surfaces and that all machine tools should be motor driven. Benches with iron tops were recommended.

In the discussion of the paper considerable objection was made to the recommendation of having iron tops on the benches. It was also suggested that a turret lathe, which was not recommended by Mr. Hendrickson, would be found to be very valuable in the tool room. A surface grinder was also recommended as being a wise addition to the list given by the author. The making of taps and reamers was discussed in connection with this paper and E. J. McKernan, A. T. & S. F., stated that it was the custom on that road to allow 1/32 over size on taps and reamers before hardening, this being found to be sufficient to permit grinding to the proper size after they were hardened. The pre-heating of carbon steel to be made up into tools was advised by another member.

On the subject of grinding wheels, H. E. Blackburn, Erie R. R., Dunmore, Pa., presented a short paper, in which he strongly recommended the use of soft wheels, stating that a wheel of from 40 to 60 grains would suitably grind and finish all work that comes to the tool room. He also recommended keeping the face of the wheel as narrow as possible. A wheel that works well on large work does not as a rule cut well on small work. He stated that the operator should dress and true the wheel between heavy and finishing cuts. Wheels should be trued with a diamond and dressed with a spur cutter. The discussion showed that other members had found the soft wheel to be preferable.

In a paper on "Standardization of Steel," Henry Otto, A. T. & S. F., strongly advised the drawing up of standards for steels suitable to the manufacture of various kinds of tools. During the discussion the point of importance of the heat treatment of the steel was presented and a large number of members stated that they were using high speed steel for practically all tools which were not so large as to make it inadvisable from the cost standpoint. Mr. McKernan stated, however, that for reamers 28½ in. in length his experience was that carbon steel was better suited on account of the use of the air motor with these tools in the hands of unskilled labor. He suggested the use of the barium chloride process for hardening wherever it was possible to use it. Other members stated that for long reamers carbon steel seemed to be better suited.

A. M. Roberts, B. & L. E., Greenville, presented a paper on "Pneumatic Tools and Appliances," in which were illustrated and described a number of tools, principally for flue work.

On the subject of boiler shop tools a paper was presented consisting largely of illustrations and descriptions of various tools for this purpose, one being shown for drilling telltale holes in staybolts, others being flue scarfing machines, flue swedging machines, gauge for threading staybolts and flanging machines.

A discussion on this paper brought out the fact that it is very advisable to have a man in the shop whose duties it is to oil and oversee the use of all air motors, air hammers, etc. If this is not done it has been found that motors are badly mistreated and are soon inoperative.

Among the other papers the one by J. Martin, C., C., C. & St. L., Beach Grove, Ind., on "Making Dies for Forging Machines" was of particular interest and accorded considerable discussion.

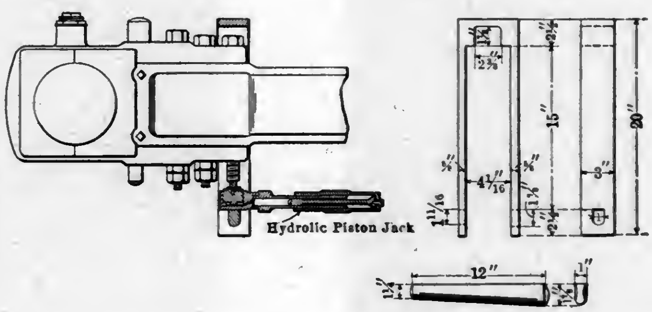
Cast steel was recommended as a material for dies of the larger size and high carbon steel in the smaller sizes. Cast iron had not been found satisfactory for this use. The dies should be tempered, but if too large for this should be casehardened on the face.

Election of Officers.—The following officers were elected for the ensuing year: President, E. J. McKernan, A. T. & S. F., Topeka, Kan.; first vice-president, J. Martin, C., C., C. & St. L., Beach Grove, Ind.; second vice-president, G. W. Jack, I. C. R. R., Chicago; third vice-president, A. R. Davis, C. of G. R. R., Macon, Ga., and secretary-treasurer, M. H. Bray, N. Y., N. H. & H. R. R., New Haven, Conn. Executive Committee—August Meitz, chairman; A. O. Dollman and E. R. Purchase.

AN INGENIOUS ROD BOLT PULLER

CHICAGO & NORTHWESTERN RY.

The accompanying drawing shows a very interesting and efficient device for removing refractory rod bolts, which has been found to be far superior to the noisy and often dangerous cannon, which many shops continue to employ when bolts cannot



be started with a sledge. This method does no damage to the bolt and is very useful in roundhouses, as it can be employed at any position of the crank pin.

The yoke shown should be made of machine steel. This is placed over the bolt to be removed and the key inserted in the keyway. The hydraulic jack is placed on top of the key and when pressure is applied the piston advances against the bottom of the bolt.

Indicative of the Efforts of the Pennsylvania Railroad to economize in every possible way is a general notice which has just been issued to the employes of the Schuylkill Division. Employes are told what it would mean to the company on the Schuylkill Division alone if each one would save ten cents a day. Enginemen are requested to be careful in the use of oil, firemen in the use of coal and clerks are asked to economize in the use of stationery and by avoiding errors.

The More Aluminium an aluminium-bronze contains, the softer it is while hot. This is the reverse of hardness of the cold bronzes. While a 10 per cent. aluminium-bronze is much harder than a 4 per cent. bronze while cold, it is very much softer while hot, and can be rolled hot much easier.

THE BUCK EXTERNAL THROTTLE VALVE

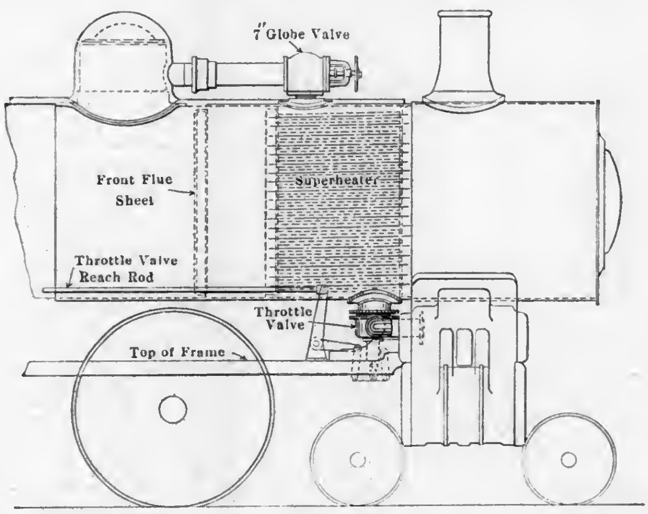
Particularly in the case of locomotives fitted with superheaters, the volume filled with steam at boiler pressure between the throttle valve and the steam chest is sufficient to make quick control of starting or stopping, especially necessary in the case of slipping, impossible. To overcome this trouble as well as to obtain a number of other equally or more valuable advantages, W. F. Buck, superintendent of motive power, Santa Fe system, has designed a type of throttle valve which is located outside the boiler shell and immediately ajacent to the steam chests. A patent has been granted covering the design.

While this throttle is designed primarily for use with locomotives equipped with superheaters, it is equally applicable to locomotives using saturated steam, and is suitable for the designs of superheaters arranged for either high or low degree of superheat.

A general view of the throttle, its connections and application in connection with a Buck-Jacobs superheater, is shown by the accompanying illustration. The throttle is secured beneath the superheater on the outside the boiler, communicating with it by means of a hole through the shell. Above the superheater is a connection to a large globe valve, and this, in turn, is connected to the dome by an outside pipe. Short steam pipes lead from the throttle to the cylinder saddle casting. The throttle is operated by a bell crank connected with a reach rod leading to the cab. The details of construction are clearly shown in the sectional view.

In the case of smoke tube superheaters, saturated steam may be led to the superheater header, either by an external pipe from the dome, or by the usual inside dry pipe. From the header, superheated steam is led to the throttle by two steam pipes, similar to the common form of smokebox steam pipe.

An external throttle valve is, of course, readily accessible at all times for inspection and repairs. This feature, especially in connection with the outside location of steam pipes and con-

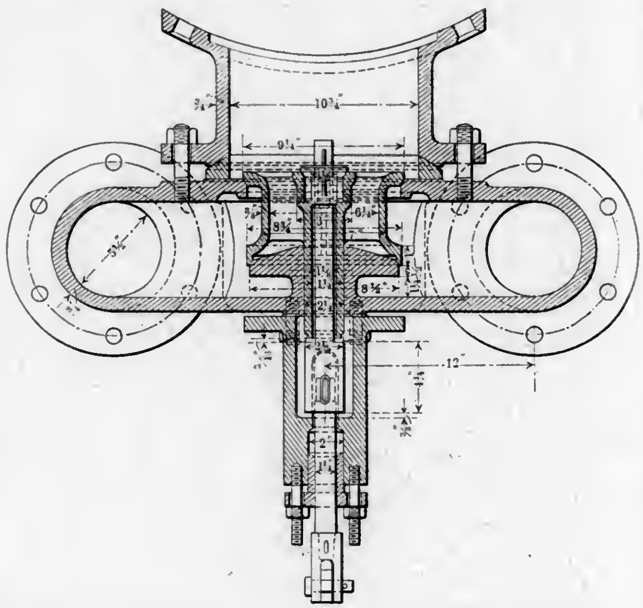


nections, introduces a desirable innovation in locomotive practice. It places the joints outside of the boiler shell where steam leaks may be quickly detected and where repairs may be made conveniently. The joints are removed from the intense heat of the smokebox that tends to cause leaks, and in the event of a leak the steaming qualities of the locomotive are not affected. With steam pipes inside of the smokebox, leaks interfere with the steaming by destroying the vacuum.

The accessibility of the throttle provides many advantages. While the boiler is under steam pressure the globe valve near the dome may be closed, thus shutting off steam from both the throttle and the superheater. Repairs to these may then be made without the long delay incident to blowing off steam, cooling boiler, removing dome cap, etc.

Should the throttle become disconnected, either open or shut, it is possible to get at it promptly. Temporary repairs may be made at once and the engine proceed with its train. In case of such an accident with the usual form of thottle it would be necessary to kill the engine. Furthermore, there is no stuffing box, gland or packing for throttle rod in cab.

Maintaining steam continually in the superheater provides



further advantage in protecting the superheater and joints from the effect of hot gases. With steam always in the superheater the metal parts will not be burned so readily.

0-8-8-0 TYPE LOCOMOTIVE WITH SUPERHEATER

DELAWARE & HUDSON COMPANY

In June of last year the Delaware & Hudson Co. received from the American Locomotive Company six very large locomotives of the 0-8-8-0 type, which were very fully illustrated and described on page 207 of the June, 1910, issue of this journal.

These locomotives were put into service on an 18 mile grade between Carbondale and Arrarat, Pa., where they have since been in use. Shortly after they were received a comparative coal and water consumption test was made between a Mallet and two heavy consolidation locomotives that had previously been used for pushers at this point. The results of this test were given in an article on page 345 of the September, 1910, issue of this journal, and showed the very great economy of the Mallets in this class of service. The coal consumption per 1,000 ton miles was .349 lbs. for the consolidation and .196 lbs for the Mallet, the water consumption, total over the division, being 12,644 gallons for the consolidation and 9,205 for the Mallet.

Experience with these locomotives has indicated that the economy shown in the test has been continued in regular service, and this company is now receiving four more locomotives from the same builders which are practically duplicates of the first order, with the exception that they have been equipped with Schmidt fire tube superheaters. It is expected that a comparative test will be made with these locomotives after they have been in service a short time, and we hope to be able to present some most interesting results from this series in a later issue.

Some slight change has been made in the valve setting on the locomotives equipped with superheaters as follows: The high pressure steam lap has been reduced from 1 1/16 to 1 in., the lead of 3/16 and exhaust clearance of 5/16 in. being the same. On the low pressure valves the steam lap of 1 in. is the same in both cases, but the lead has been increased from 3/16 to 5/16 in. and the exhaust clearance increased from 3/8 to 7/16 in.

The application of the superheater has, of course, changed the boiler construction somewhat, and the new engines have 270 2¼ in. tubes 24 ft. long, as compared with 446 tubes of the same diameter and length in the non-superheater engine. Offsetting this difference, however, there are 42 5½-in. tubes for the superheater elements, making the total evaporative heating surface of the superheater engine 5,598 sq. ft., as compared with 6,629 sq. ft. in the former design. The superheater has a heating surface of 1,106 sq. ft., and if we consider each sq. ft. of this area equivalent to 1½ sq. ft. of boiler heating surface, as tests have indicated to be correct, the equivalent heating surface of this boiler as compared with the other is 1,257 sq. ft.

The application of the superheater has increased the total weight of the engine from 445,000 to 457,000 lbs. The same steam pressure, cylinders, diameter of boiler and other features are used, as will be seen by reference to the following table of general dimensions:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel tractive effort (compound)	105,500 lbs.
Tractive effort (maximum)	126,609 lbs.
Weight in working order	457,000 lbs.
Weight on drivers	457,000 lbs.
Weight of engine and tender in working order	625,800 lbs.
Wheel base, rigid	14 ft. 9 in.
Wheel base, total	40 ft. 2 in.
Wheel base, engine and tender	75 ft. 7½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.34
Tractive effort x diam. drivers ÷ equivalent heating surface	742.00
Evaporating heating surface ÷ grate area	55.98
Firebox heating surface ÷ total heating surface per cent	6.32
Weight on drivers ÷ total heating surface	82.00
Volume equivalent simple cylinders cu. ft.	26.00
Equivalent heating surface ÷ vol. cylinders	279.00
Grate area ÷ vol. cylinders	3.85

CYLINDERS.

Kind	Mellin Comp.
Diameter and stroke	26 and 41 × 28 in.

VALVES.

Kind H. P.	Piston
Kind L. P.	Slide

WHEELS.

Driving, diameter over tires	51 in.
Driving journals, diameter and lengthh	10 × 12 in.

BOILER.

Style	Conical
Working pressure	220 lbs.
Outside diameter of first ring	90 ins.
Firebox, length and width	126 × 114 in.
Tubes, number and outside diameter	270—2¼, 42—5½ in.
Tubes, length	24 ft.
Heating surface, tubes	5,245 sq. ft.
Heating surface, firebox	353 sq. ft.
Heating surface, total	5,598 sq. ft.
Superheater heating surface	1,106 sq. ft.
Grate area	100 sq. ft.

ADVANTAGES AND DISADVANTAGES OF OIL FUEL FOR LOCOMOTIVES

In a very valuable paper presented by Eugene McAuliffe before the Railway Fuel Association the following discussion of oil fuel for locomotives appeared:

The principal advantages incident to burning oil as compared with coal can be summed up as follows:

1. *Cost.*—This item depends entirely on relative price at mine and well plus freight to point of consumption. In computing freight haul tariff rates must govern when moved over foreign lines the actual cost of moving (not including what is known as fixed charges) ordinarily used in computing cost over home rails. In making these computations the fact that from 1,000 to 1,500 pounds of oil equal 2,000 pounds of coal must be taken into account.

2. Decreased cost of handling oil from cars to engines with practically no loss by depreciation due to such handling, all coal suffering badly in passage through coaling plants of whatever type.

3. The losses by evaporation suffered by coal do not apply to oil, neither does loss by theft in transit occur, oil reaching engine tenders unimpaired as to quality and undiminished in quantity.

4. Saving of time at terminals and increased mileage per engine, it being unnecessary to cut engines out for fire cleaning; the oil capacity of tender approximating 150 per cent. of that of coal, making longer runs possible.

5. Freedom from physical failure of firemen in extreme hot weather, the fireman's work actually lighter than that of the engineer.

6. Stability of delivery, oil unaffected by labor conditions which has made the production of coal in some sections so uncertain as to necessitate the storage of immense quantities of coal at great expense, this condition occurring at frequent intervals

7. Greater cleanliness in handling of passenger trains with almost absolute immunity from right of way fires, saving the cost of fire-guards, reducing also claim department losses.

The drawbacks to the use of oil have been in the direction of uncertain supply. The expense of equipping the average locomotive to burn oil approximates $800: the cost of constructing steel storage tanks of large capacity approximates 25 cents per barrel, the necessary terminal facilities, however, cost but about 50 per cent. of the amount required to handle coal, coaling facilities, however, usually in place, the oil facilities when installed representing a duplication. Frequently before the producer is able to judge his production sufficiently well to warrant the making of definite contracts, large quantities of "pot" oil must be sacrificed for want of storage or market facilities. After the production is reasonably well determined, an interval of time is necessary to transform locomotives, these factors embarrassing both to the oil producer and the railroad consumer. With the development of new fields and the purchase of large numbers of cars, together with the increased installation of oil burning apparatus this condition will prove less burdensome in the future than in the past.

The relative expense of oil and coal as a locomotive fuel is a subject without the province of this Association to discuss and well so, inasmuch as any road contemplating the use of oil must necessarily test the grade of oil or residuum it expects to burn against the grade of coal it is to be substituted for, different coals grading within greater extremes than do oils, which, if proper allowance is made for water and sediment in the case of crude oil purchases, will show a limited variation in the number of British Thermal Units per pound of fuel. It is, however, within the scope of this Association to discuss the possible economies to be effected in the use of oil and in that connection it is the writer's opinion that actual service will not show the same results when figured against coal that a careful test will evidence. This is due to the fact that with coal the physical limitations of firemen in hard service plus the ability to consume a certain amount of coal per square foot of grate surface per hour are factors which largely determine the position of the reverse lever and throttle in the hands of the average engineer. Roughly speaking, with the oil burner "the crew are due at the next town when they whistle off from the one they are leaving," this frequently necessitating the unmerciful (to the fuel bill) use of notches as well as both injectors; the temptation is great and usually, except when trains are right on time, is one that is availed of. A little more oil plus a slightly wider opening of the steam jet reinforced with a few quarts of sand, will usually suffice to answer the increased demand of the reverse lever with a consequent loss of fuel incident to the failure to profit by the expansive use of the steam in the locomotive cylinder, this handling responsible for the actual ratio running higher than that shown by careful tests. Another reason for the excessive consumption of oil is that a comparative lack of engine failures for steam has resulted in a weakness in the element of supervision, men as well as mechanical facilities allowed to deteriorate as result of the comparative freedom from failure to actually deliver the train on time.

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* Denotes illustrated article.

VENTILATION

There is no doubt but what the traveling public is becoming each year more demanding in regard to the ventilation and heating of passenger cars, and in view of the policy of the railroads to not only comply with every public demand, but to anticipate it if possible, any information on this subject is, at this time, particularly valuable. The experiments made by Dr. Crowder and reported by him to the American Public Health Association throw considerable new light on the subject and clear up a number of heretofore debatable points. A liberal abstract of his very complete and extensive report will be found on page 369 of this issue.

In considering this report it should be remembered that the results quoted apply only to sleeping cars, and while he concludes that the condition in these cars even without special ventilators is not serious, the same thing would not apply to ordinary coaches where there are from two to three times as many passengers.

The main object of the experiments was to determine if ventilation by exhaustion was a satisfactory method and on this feature the results are very conclusive. The difference in the carbonic acid content of the air in cars fitted with ventilators as compared with those using only open deck sash was very marked and there seems to be no doubt but what if sufficient ventilators of this type are applied to take out the air there can be any desired supply of fresh air for passengers obtained in any type of car.

Dr. Crowder states that he believes, in the case of sleeping cars, the greatest danger to public health is found in overheating and recommends that careful attention be given to the matter of closer control of this feature so that the supply of heat can be quickly adapted to the rapidly changing conditions of a passenger car. While this criticism is more properly applied to sleeping cars than to coaches, it is still worthy of careful attention on the latter, particularly on all steel equipment where the very large radiating surface required for severe weather will quickly result in overheating in ordinary weather unless arranged for close adjustment.

APPRENTICESHIP FOR THE FIREMAN

Apprenticeship courses have been or are being installed on practically all the more progressive railroads and the question of whether they pay or not, at first so frequent, is now seldom heard. There is no doubt in the mind of anyone who has followed the work of the pioneers that they are profitable in a real tangible manner.

This being so in the case of apprentice machinists, boilermakers, etc., what might be expected from an equally serious attempt at training locomotive firemen? These men have it in their power to save vast sums in the aggregate if they are properly taught to do it. All companies claim that they train their firemen, and so they do generally in about the same way they formerly trained their apprentices and with about as successful results. Properly trained apprentices have proven their value and firemen trained in a similar serious systematic manner will prove much more valuable.

In a paper on the Railway Fuel Problem before the International Railway Fuel Association, R. Emerson presents some statistics on the cost and possible savings in locomotive fuel which strikingly illustrate the importance of the subject. He states that the cost of railway fuel in this country is equal to a tax of three cents a day, or two per cent. of his wages, for every able-bodied man on the continent. At least twenty per cent. of this can be saved, which would mean the distribution of forty million dollars yearly in dividends—an indirect or direct contribution of over $2.00 to the income of every family in the Union. Mr. Emerson says that while twenty per cent. saving has been assumed, his experience indicates that the introduction of a comprehensive and effective fuel supervision on almost any

individual railroad will in less than five years result in a reduction of between thirty and forty per cent.

Of this saving it is claimed that nearly one-half can be made by the engine crew. In the necessary instruction to bring the best results, seventy-five per cent. of personal individual practical instruction on the road and twenty-five per cent. of academic or general instruction is recommended. For road instruction one instructor to fifty engines is stated to give good results

Among a number of other very sensible suggestions made by Mr. Emerson is one concerning the fuel furnished the fireman, which, while not new, has been put into practice in very few instances. This relates to screening run-of-mine coal and eliminating all slack, which if no profitable use, such as briquetting, could be found, it will pay to throw away. It is truthfully said that it seems folly to decrease by some five to twenty per cent. the earning power of a train merely for the privilege of making the fireman, already working near his capacity on the larger locomotives, heave through the firedoor a lot of dust of doubtful, if not absolutely useless and deleterious fuel value.

The proper training of firemen would teach them how to fire any grade or quality of fuel to the best advantage and up to the point where physical limitations are reached it would make the practice of screening less important, but where both are done the horse-power of the fireman will reach a figure that will make the present average output ridiculous.

SUPERHEATING AND SMALL LOCOMOTIVES

Over five years ago it was pointed out in these columns that the superheater appeared to offer an excellent opportunity for increasing the capacity of smaller locomotives, so that they might still be retained in a service which had grown too heavy for them in their present condition.

Taking the country as a whole, it is without doubt the local trains that have the greatest difficulty in maintaining their schedule and it is often here that the greatest demand on the locomotives is made for short periods. In an attempt to keep these very important trains on time larger locomotives have been assigned to this service until it is not unusual to see trains which are absurdly unbalanced in their locomotve power. A recent instance noticed which illustrates this feature was a train consisting of a large Pacific type locomotive, which with its tender weighed about 190 tons, and four light cars, a baggage and three coaches, that with their load would hardly total to the weight of the locomotive and tender. That such an arrangement is very uneconomical from a motive power department standpoint is undeniable, and in fact it is open to question if the train was not uneconomical from every standpoint.

There has been so far very little attention given to the superheater in this service, but since its value and economy are becoming every day more assured it would seem about time to investigate the possibilities of keeping the smaller and lighter locomotives with their comparative low cost of maintenance and greater reliability in local service. There has never been a better or more satisfactory locomotive built, up to the limits of their capacity, than the old 10-wheelers, or the American type. Why not see what can be done about raising the limits of the capacity and retaining the many advantages of these locomotives?

SUGGESTION FOR RAILROAD CLUBS

At the last convention of the International Railway General Foremen's Association, through the absence of the reports from two committees and the merging of the third committee's report, there was practically but one subject presented for discussion. Contrary to what might have been expected, this proved to be a most valuable meeting for all in attendance and at no time was there any let-up in the interest or scarcity of speakers. In fact, it was found that five active sessions were not nearly sufficient to exhaust this single subject. It very fortunately happened that the subject of "How Can Shop Foremen Best Promote Efficiency?" was allotted to a committee of one, T. C. Pickard, who gave sufficient time and thought to it to fully develop its phases, which he presented to the members in the form of a series of definite questions. By thus dividing the main subject into its component parts a large amount of time was saved to the meeting and the members spoke directly upon the point under discussion, resulting in meetings of positive value and clear-cut ideas, and covering, so far as the time available permitted, the phases discussed in the very best manner.

It is probable that the members of this Association in attendance would not have received nearly as much help from the convention if there had been eight or ten or even four different primary subjects brought up for discussion as they did from a concentration on this single one. The thought is suggested that some of the railroad clubs could adopt this idea and lay out a schedule at the beginning of the year in which different phases of the same subject would be brought up for discussion at the various meetings during the year, so that at the end of the season the volume of its proceedings would form a thesis of unusual value on the subject selected. If several of the clubs followed the same plan, it would not be long before a library of the various club proceedings would be of the utmost value. Furthermore, railroad men throughout the country who had given special attention to the subject under discussion at any of the various clubs, would undoubtedly make every effort to attend the meetings. Subjects that might be profitably discussed in this manner could include fuel economy, shop design and arrangement, locomotive terminals, organization and many other similar large problems which are capable of clear subdivision.

ASSIST THE COMMITTEES

There was much just complaint at the last railway mechanical conventions over the late receipt of the reports of committees, making it in many cases entirely impossible for a member to become even generally informed on their contents. Such a condition, of course, largely defeats the object of the association particularly so in the case of the Master Mechanics' Association.

In an open discussion of this trouble on the floor, a number of explanations and suggestions were presented which, if remembered and followed out, will probably largely correct the difficulty. It was pointed out that the by-laws of both associations required the submission of all committee reports by April 1, which, if lived up to, would obviate all the trouble. It was explained, however, that in many cases, in spite of all they could do, the committees were not able to get the information required from the members promptly and their reports would be badly delayed from that cause. Then followed the explanation that it often took from 30 to 60 days, or even longer, to obtain the information requested by the committee and the requests were not sent out early enough.

The lesson from the whole discussion seemed to be that the committees should be appointed earlier, should get down to work earlier and that members should not wait for requests for information, but should forward to the committees anything pertaining to their subject which came to their attention.

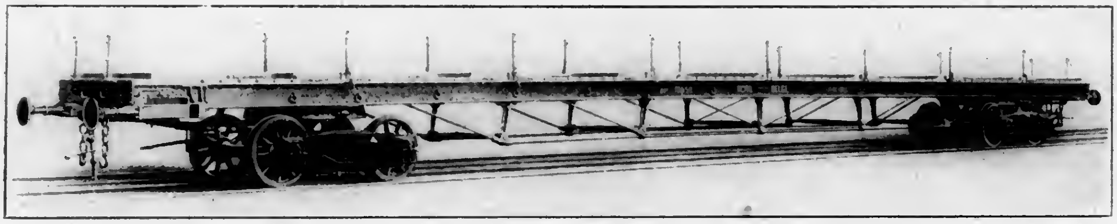
In accordance with this, the executive committees of both associations have shown their desire to do their share and have already met and selected the committees for next year's work and have sent them out for publication. (See page 375 of this issue.) It is now up to the committees, and especially to the members, to do as well. The subjects to be discussed are now known, the names of the members of the committees are available and it is the duty of every member of the association to promptly notify some one of the committees of anything which he believes they would be interested in. Don't wait for the receipt of a list of specific questions. The committees are entitled to the voluntary assistance of every member and should, in fact must, have it if the best results are to be obtained. If you don't give this assistance you have no right to complain at the lateness of the reports.

AN UNUSUAL TYPE OF FLAT CAR

A very interesting example of a foreign built long flat car has recently been turned out from the works of Usines et Acieries Leonard-Goit, of Marchienne-au-Pont, Belgium, for the North Belgium Railway. In addition to its exceptional length, 83 ft. over buffers, it embodies several distinctive and ingenious features in construction so entirely at variance with American ideas which prevail in the design of long shallow cars that it becomes entitled to more than a passing mention.

Although the car is 79 ft. 4¾ in. over end sills, a most unusual dimension in the practice of any country, it will still be noted that the longitudinal sills are extremely light in appearance, and if the usual construction were followed, would certainly indicate the prospect of an early sagging of serious proportions. These, however, consist of two series of channel section girders placed back to back, each measuring 12¼ x 3⅝ in. of five as shown. The cables have diameters of ¾ in., 1⅜ in., and 1⅝ in., and are constructed on a spiral system. Their tensile strength is 76.2 tons per square inch, so that the resistance to rupture is largely in excess of the usual factor of safety required in ordinary service.

The detail drawings of the arrangement of the struts and the cable "anchorage" show clearly the means employed to firmly secure the latter against any possibility of slip. Each end of the cable is firmly held on its respective platform in a hollow conical piece of steel (a), inside which the cable strands, having been unraveled and twisted back on their ends, are embedded in white metal. This piece (a) is for part of its length cut with a screw thread to engage in a cap (b) which abuts against one of the distance pieces of the longitudinal sills or girders; this distance piece, being bolted between the two members constitutes an effective anchorage for the cable. Any desired strain on the cable is effected by screwing the cap to the left or right, the cable being prevented from twisting with the



UNUSUALLY LONG FLAT CAR WITH CABLE TRUSSES.

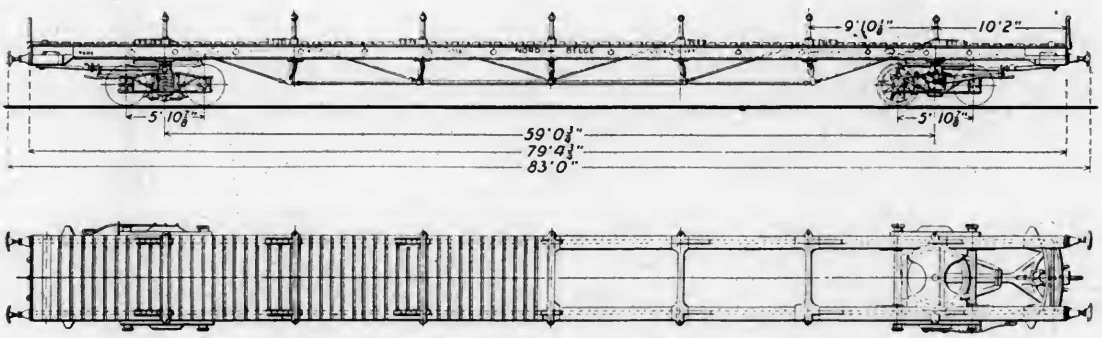
The two members composing one girder are held about 2 in. apart by distance pieces at intervals of 4 ft. 11 1/16 in. The two principal girders or longitudinal sills, which are 4 ft. 6¾ in. apart, are firmly braced together by cross braces, placed at intervals of 9 ft. 10⅛ in., the bracing being strengthened by gussets. The battens composing the platform assist in giving transverse strength, and this is claimed, despite the oddity of the general arrangement, to be more than ample for the requirements of the service.

As regards vertical strength the dimensions of the girders given afford no measure of this factor. The girders, in fact, constitute the compression members of a truss, the tension members of which consist solely of a steel wire cable. These latter, in their function as truss rods, constitute the most novel feature in connection with the car. At first glance they would suggest an extremely questionable arrangement for resisting deflection, but a careful examination of the accompanying illustrations will show that the scheme in its assembled entirety embodies a decided factor of strength which is not apparent at a casual examination.

In the car under consideration there are three different strengths of cable employed for the three separate series of bracings. In cars of the same load capacity, but having a length over end sills of 60 ft. 8¾ in., only three struts are used instead

cap by the square portion of (a), which fits loosely in the upper casting of the distance plate.

The design of the struts over which the cables are stretched is also shown in the drawing referred to. Their upper ends are hinged to accommodate movements of the cable, and in order to prevent them from slipping, and so releasing the tension. They are "stopped" at the proper angle by means of the heel pieces (c) which abut against them on either side. The piece (c) encloses the cable, and terminates in a long thin cone, saw-cut in four places, over which a sleeve fits, and is screwed to the heel piece as shown. This sleeve serves to tighten the cone on the cable, and so gives a strong grip on

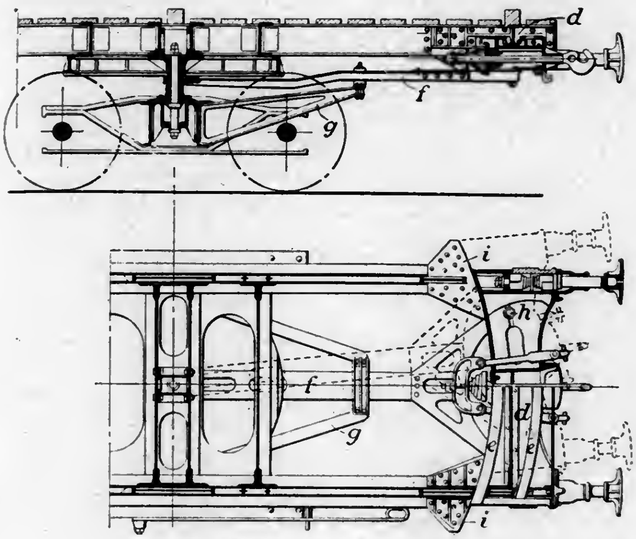


ELEVATION AND PLAN, SHOWING FRAME CONSTRUCTION.

the latter. Each pair of struts is held together transversely by means of a cast steel cross bar which helps to give rigidity to the whole structure.

Another and practically as important a feature of this car is the system of buffing adopted. It is well known that the use of rolling stock having great variations of length constitutes a source of difficulty and danger when employed indiscriminately on sharp curves, owing to the locking of the buffers, and it is obvious that a car of such exceptional length could not be expected to work safely with one of the usual foreign four-wheel type. Accordingly a system of radial buffers has been introduced as shown in the drawing in plan and section

of that part. This construction is as follows: To each end of the truck a slide block (d), made in the form of an arc of a circle, having its center at the center of the truck center pin, is attached by plates riveted to the longitudinal sills A cast steel sector (e), carrying the drawbar and buffing apparatus, rests on this slide block, and bears on it by eight rollers, which

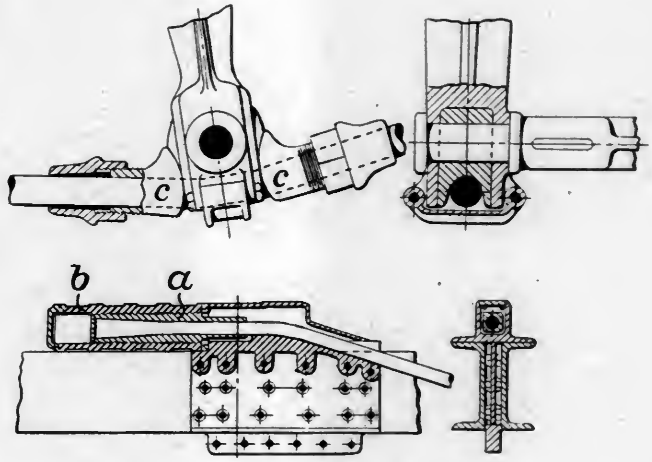


ARRANGEMENT OF RADIAL BUFFERS.

assist in reducing friction. The section (e) is controlled by a fork (f) leading from the truck center pin which passes through a guide collar (g) placed at the end of the truck.

Under these conditions, when the car encounters a curve, the truck, guided by its wheels on the rails, pulls with the fork (f), and this by means of the two pins (h) swings the whole buffing apparatus to one side or the other, independently of the car itself. On sharp curves the buffers are swung quite outside the line of longitudinal sills, as shown in the illustration to which reference is made, and in order to support the sills from breakage, cast steel buttresses (i) are bolted to their outside faces

It will be noted in a study of this very interesting car that it embodies an absolute departure in practically all details from accepted ideas in this country, and its unique construction will



DETAILS OF STRUTS AND CABLE ANCHORAGE.

scarcely carry any particular appeal. Honest workmanship with adequate inspection might attain the ends desired, but a mere casual study of the various features which have been described must convince that the opportunity, or the liability, to turn out poor work is too much in evidence to popularize the design. The weight of this 80,000 lbs. capacity car is only 16 tons, a saving of about six tons as compared with other flat cars of similar capacity, and the claim is advanced that this rather startling method of construction gives far greater strength on the smaller total weight.

Measurement of Steam Discharge in Locomotive Pop-Valves

RECORD OF ELABORATE TESTS MADE AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY WHICH AFFORD THE MOST COMPLETE AND RELIABLE DATA TO BE GATHERED ON THIS IMPORTANT SUBJECT.

Somewhat over a year ago Edward F. Miller, Professor of Steam Engineering at the Massachusetts Institute of Technology, was commissioned by the Crosby Steam Gage and Valve Co. to undertake an exhaustive test of the steam discharge afforded by the Crosby muffled locomotive pop safety valves. Primarily the object was to determine with absolute certainty how much steam these appliances will discharge, and how they will relieve a boiler and the work was carried on at the Massachusetts Institute because no commercial plant was found where the large steam supply could be uniformly maintained under absolute control.

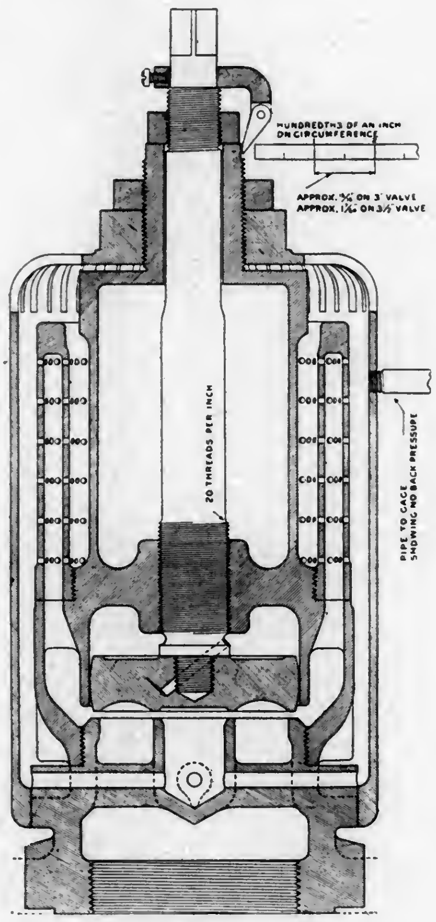
Every precaution that the best engineering experience, skill and foresight could suggest was observed to avoid errors. All the readings and measurements were made by Professor Miller personally, and the results can be accepted with confidence. The report as he has submitted it has been published by the Crosby firm because of its scientific importance and interest to the engineering world. The effect of slight changes of orifice form and proportion in greatly increasing the steam discharge is clearly demonstrated. The report which will repay a careful analysis follows practically in full:

In all of these tests the valves were without springs and were set at a definite distance from their seats and held there rigidly during the tests. In order to avoid unequal expansion, the metal of the valve body and of the spindle was made the same. By reference to the drawing it will be seen that the spring was replaced by a spindle attached rigidly to the valve. This spindle extended through the top of the valve, and carried at its free end a pointer traveling over a graduated cylinder. The lower part of the spindle was threaded near the valve with a 20 thread. The graduated cylinder at the top was divided into five parts, each part representing 1-100 in.

A motion of the pointer of approximately one inch corresponded to 0.01 in. lift of the valve from its seat. Tests on the 3 in. valves were run with lifts set at 0.10, 0.08, 0.05 and 0.02 in. Tests on the 3½ in. valves were run with lifts set at 0.08, 0.05 and 0.02 in. These valves were connected with the boilers through a line of 5 in. pipe, into which two Babcock and Wilcox boilers of 500 boiler horsepower discharged. The 5 in. pipe connected with a 10 foot length of 10 in. pipe, on the end of which was a blank flange 2 in. thick, to which the safety valve was bolted. This flange was bored on the bottom with a hole considerably larger than the inlet to the valve. The entrance edge of this hole was rounded with a curve of one inch radius. On the other side of this blank flange, and enclosing the safety valve, was a 10 in. flanged tee. The outlet of the tee led to the

condenser. The end of the tee on the straight run was covered with a blank flange. Between runs this blank flange on the end of the tee was removed, and the setting of the valve changed. After each run the valve was examined to see if it had moved from its previous setting.

The steam passing through the valve was condensed in a surface condenser which was tested immediately before and immediately after each test for tightness. The condenser was found to be absolutely tight. In every case the outer muffler casing was screwed down to its lowest position. The steam was led from the boiler through a small separator in the boiler room,

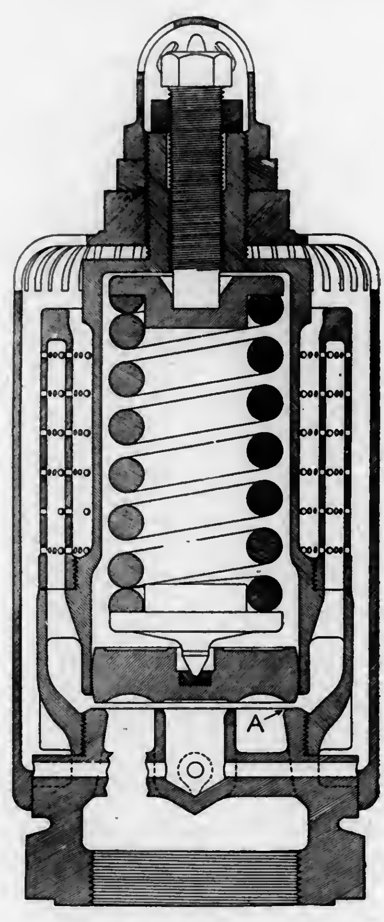


VALVE ARRANGED FOR TEST.

then through a second separator located about 20 ft. from the safety valve. A calorimeter was attached to the 10 in. pipe about 8 ft. from the safety valve, and the quality of the steam determined. In all of the tests the steam was practically dry. To see whether or not there was any pressure in the muffler, a copper pipe was connected and led outside of the 10 in. tee, and a low pressure gage attached. In no case was there any pressure shown by this gage.

The boiler gage used was a Crosby standard test gage attached to the 10 in. pipe. In nearly all of the tests the gage was read at one minute intervals. The pressures given in the tables are the average of five readings. The pressure coming on the valve tends to make the opening through the valve greater than the "lift as set," due to the yielding of the metal. To determine this yielding, the valves were placed in a small Riehle testing machine, and a load equal to the steam pressure on the bottom of the valve applied to the valve. The additional opening due to this yielding was determined by micrometer measurements. The tank weights as taken are given in every case.

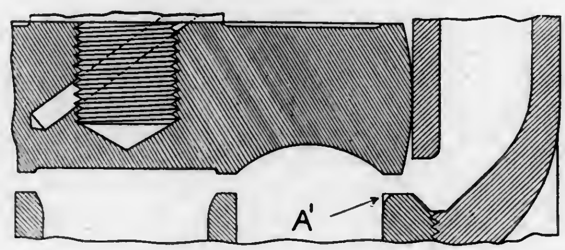
All tests with low lifts were made at least sixty minutes long to minimize any error due to difference of level in the hot well under the condenser. The condensed steam is pumped out of the hot well by a pump operated through a float and valve. A difference of about one inch is required ordinarily to make this float operate. An inch difference in level in the hot well means an error of 9 pounds of water. The different results are appended to the report in tabular form. The different tests on



VALVE SHOWING ROUNDING OF SEAT.

one valve have been reduced to a common pressure by assuming the discharge through a given orifice to be proportional to the absolute boiler pressures. For such small variations in pressure as there were in these tests these assumptions can introduce no error.

The lift of the valves could be set with an accuracy as great



ENLARGED VIEW OF VALVE SEAT.

as that of the 20 thread screw. As the total motion was only 1-10 in., it is probable that the error from this source is not over half a thousandth of an inch. The difference in expansion due to temperature between the body of the valve and the valve and its spindle was obviated in all cases by making these metals the same. Furthermore, in testing the valves, the adjustments and settings were always made while the valves were hot, practically at the temperature of the valves during a test.

The additional lift, due to the yielding of the metal due to the steam pressure on the under side of the valve, was determined in the case of each valve. The movement of the valve with reference to its seat was measured by a micrometer caliper.

Different sets of readings on any valve varied 0.0005 in., and the results are liable to be in error by this amount. It is probable that, considering all of the errors in determining the total lift of the valve, the result is good to about 0.001 in. The condenser in which the steam was condensed was an Alberger bottom inflow surface condenser with hot well at the bottom. Besides the regular drain to the hot well there were additional drains of 4 in. pipe, one from each end of the condenser to the hot well. The level in the hot well varied about one inch, which corresponds to about 9 pounds of steam. Each weighing of a tank empty as a tank full is good to ½ lb. In the runs with 0.008 and 0.10 in. lift, if all errors in weighing are assumed to be cumulative and an error of one inch in the level in the hot well be also considered, the maximum error is 15 lbs. The probable error is less than this, but even this is a small percentage of the total.

In the case of 0.02 in. lift the maximum possible error due to all sources would be 12 lbs., and for the very worst case this is 12 in 2,845, or less than five-tenths of one per cent. The results of the calorimeter tests are good within 2 in the third decimal place. The pressure readings by the boiler gage were taken at one minute intervals during most of the time. Occasionally, when the pressure was varying, these were taken more frequently. The boiler gage was recalibrated and found accurate.

The summary of results accompanying the above valuable report demonstrate conclusively the advantageous effect of slightly rounding the turn to the seat passage in securing a greater volume and weight of steam discharged. This was, however, only to the small extent that the same castings would permit, no changes in the patterns being made for this. Reference to the drawing herewith will illustrate the very light chamfer referred to. In the tabulated summary of tests the valves so treated are designated as "rounded edge," and those with the usual angular corner as "square edge." It may be well to add in connection with these same tables that the letters (J) (O) (A) and (B) have no significance, being stamped upon the valves before the tests simply as a convenient method of identification.

3-INCH CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVE

Flat Seat (Rounded Edge), Valve marked "O"

Lift of valve as set	.02	.05	.08	.10
Total lift, including yielding of metal	.0247	.0547	.0847	.1047
Pounds discharged per hour	3,309	7,250	10,414	12,442
Boiler pressure (gage)	209.0	205.8	201.3	198.3
Pounds discharged per hour, reduced to 200 pounds gage	3,178	7,059	10,352	12,542
Pounds discharged per minute, reduced to 200 pounds gage	52.9	117.7	172.5	209.0

3-INCH CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVE

Flat Seat (Square Edge), Valve marked "J"

Lift of valve as set	.02	.05	.08	.10
Total lift, including yielding of metal	.0247	.0547	.0847	.1047
Pounds discharged per hour	2,845	6,313	9,342	11,222
Boiler pressure (gage)	208.0	201.0	201.5	201.0
Pounds discharged per hour, reduced to 200 pounds gage	2,743	6,284	9,277	11,170
Pounds discharged per minute, reduced to 200 pounds gage	45.7	104.7	154.6	186.2

3½-INCH CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVE

Flat Seat (Rounded Edge), Valve marked "B"

Lift of valve as set	.02	.05	.08
Total lift, including yielding of metal	.0251	.0551	.0851
Pounds discharged per hour	3,989	8,482	12,172
Boiler pressure (gage)	209.2	202.7	199.5
Pounds discharged per hour, reduced to 200 pounds gage	3,825	8,377	12,201
Pounds discharged per minute, reduced to 200 pounds gage	63.7	139.6	203.4

3½-INCH CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVE

Flat Seat (Square Edge), Valve marked "A"

Lift of valve as set	.02	.05	.08
Total lift, including yielding of metal	.0251	.0551	.0851
Pounds discharged per hour	3,688	7,688	11,319
Boiler pressure (gage)	212.5	204.2	205.0
Pounds discharged per hour, reduced to 200 pounds gage	3,485	7,541	11,062
Pounds discharged per minute, reduced to 200 pounds gage	58.1	125.7	184.4

As these valves are intended primarily for railroad service, it is of considerable interest to make some calculations to show what these figures mean in discharge capacity as applied to their use on locomotives. Having now further exact determinations of the safety-valve discharge, free from any elements of uncertainty and requiring no estimates of probable performance, it is possible to arrive at fairly reliable results, since the steaming capacity of various locomotives is known to a very satisfactory degree of accuracy.*

Professor Miller found by experiment that it was not practicable to eliminate the effect of the stress of the steam pressure against the face of the disc while the valve was discharging. By careful measurement, as shown in his report, this thrust was determined to be 0.0047 of an inch in the 3-inch valves and 0.0051 of an inch in the 3½-inch valves, and he reckoned the actual seat opening as tnis much more than the apparent lift of the disc indicated on the micrometer spindle. This strain of the parts was thus measurable, even though effort had been made to avoid it by placing the threaded support for the spindle very close to the disc itself.

As the basis for easier comparison, the totals given in the summary tables prepared by Professor Miller to accompany his report have been reduced to the equivalent amounts for exactly 0.08 of an inch lift of the disc from its seat, and for various boiler pressures, especially for convenience in calculating the discharge afforded in case where the valves are used in pairs, set, for example, at 200 lbs. and 205 lbs., or at 180 lbs. and 185 lbs. respectively. If greater or less lift than the recommended 0.08 in. is preferred the amount of the discharge may be calculated from the exact valve seat area, or can be taken as fairly proportional to that given in the tables for the same pressure.

It is well now to consider how much steam discharge may be required for the different types of locomotives, and how Crosby muffled valves would take care of any steaming capacity. At the Master Mechanics' Convention in June, 1910, the Committee on Safety Valves reported that investigations were made by E. D. Nelson, engineer of test, Pennsylvania Railroad, on loco-

* See also American Engineer, April, 1909, page 162.

motives carrying 200 lbs. gage pressure and having 4,231 sq. ft. of heating surface and $56\frac{1}{2}$ sq. ft. of grate area, and that the maximum steam discharge or evaporation was 2.44 lbs., the minimum 1.18 lbs. and the mean 2.05 lbs. of steam per square foot of heating surface per hour and the committee recommends the following formula providing for safety valve capacity to discharge twice this mean amount, or 4.1 lbs. of steam per hour per square foot of heating surface:*

$$A = \frac{0.08 \, H S}{P}$$

A = Outlet of valve in square inches.
H S = Boiler heating surface in square feet.
P = Absolute pressure, = gage pressure + 15 lbs.

For a locomotive of the given 4,231 sq. ft. heating surface, this formula would mean safety valves capable of discharging 17,347 lbs. of steam per hour; and it will be seen from the tests that two Crosby 3 in. muffled valves at exactly 0.0847 in. lift discharge 20,704 lbs. of steam per hour at 200 lbs. gage pressure. If one of these valves were set at 200 bs. and the other at 205 lbs. and regulated to lift only 0.08 in., it is found that one valve would discharge 9,872 lbs. and the other 10,102 lbs., or a total of 19,974 lbs. of steam per hour, even with this smaller lift, an amount amply in excess of the total required under the proposed rule.

Professor Miller's test shows that, allowing 4.1 pounds per hour per square foot of heating surface, two of these 3-inch valves at 0.0847 of an inch lift will amply provide for locomotives having heating surface up to 5,050 square feet and two Crosby $3\frac{1}{2}$-inch valves at 0.0851 of an inch lift are sufficient for locomotives having 6,000 square feet of heating surface, if such were to be built. Even if regulated to permit only 0.0547 of an inch lift, the two 3-inch Crosby valves are sufficient for locomotives up to 3,443 square feet of heating surface, if both valves were set at 200 lbs. and advantage were not taken of the greater steam discharge afforded by setting one of them at the higher pressure of 205 lbs., for example. There is also the further assurance derived from past experience that even under the most severe requirements of heavy steaming in freight service on Western mountain railroads, on locomotives that have been equipped with three 3-inch Crosby valves, set only 2 lbs. or 4 lbs. apart, the third valve has never been known to blow.

The Lake Shore and Michigan Southern Railway has, for the past two years, been handling its scrap material by means of a gantry crane and lifting magnet, at a cost of from four to seven cents a ton, or from ten to twelve cents per ton in and out, including sorting. Before the installation of the crane and magnet, in May, 1909, the cost ranged from thirty to thirty-five cents a ton, which is about the usual cost for handling such scrap material by hand with what are considered to be good facilities.

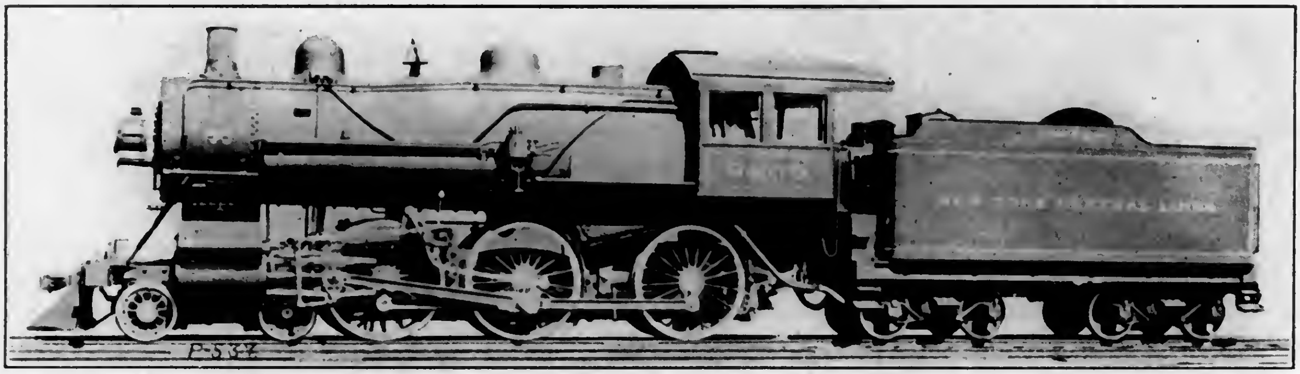
* See American Engineer, Aug., 1910, page 317.

EXPRESS LOCOMOTIVES WITH ALLFREE CYLINDER AND VALVES

PITTSBURGH & LAKE ERIE R. R.

The Pittsburgh & Lake Erie Railroad, one of the New York Central Lines, has had for several years a number of locomotives of different types, equipped with the Allfree system of cylinders and valves, which has been previouslly illustrated and described in this journal.* These engines are of the 2-8-0 freight, 4-4-0 and 4-6-0 passenger types, and have proved so satisfactory that five additional of the 10-wheel type, as herewith illustrated, have recently been completed at the Pittsburg works of the American Locomotive Company.

The requirements of the Lake Erie passenger service are very severe, and locomotives capable of sustaining great power and speed are a necessity. For instance, from Youngstown, O., to Pittsburg, Pa., 65 miles is made in 90 minutes with stops at New Castle Jn., Beaver Falls, Brighton and Beaver, with a minimum weight behind the tender of 300 tons. On frequent occasions this latter rises to 600 tons, and the average train may be set at 400 tons, irrespective of engine and tender. The road has several grades and a number of high degree curves, in addition to points where speed must be reduced. In consequence, besides the requisite of sustained high speed, rapid



ALLFREE TYPE LOCOMOTIVE FOR PITTSBURGH AND LAKE ERIE R. R.

acceleration becomes imperative. In this class of work the Allfree type of 4-6-0 locomotive has proved all that has been claimed for that system, and duplication of the original design becomes fully consistent.

The new lot of locomotives accordingly reproduce the former order, and to still further enhance their efficiency they have been equipped with the Locomotive Superheater Co.'s† standard fire tube superheaters. This latter feature is probably the most interesting detail in connection with this order as it represents the first application of superheat to the Hobart-Allfree valve and cylinder arrangement. A test of these locomotives will no doubt be very closely watched by motive power officials, and inasmuch as the Allfree system has produced very uniform results in fuel economy and in increased hauling capacity, the addition of the superheater, which has been thoroughly tested on the New York Central Lines, should show a very gratifying increase in efficiency.

With these exceptions the new locomotives do not embody any particularly original or novel features. The general design as marked out is very attractive, and may be taken as the best American representative of the 10-wheel type, of which comparatively few have been constructed in recent years.

More Than 1,000,000 Tons of Iron Ore have been shipped from Bell Island Mines, Newfoundland, this year by the Dominion Steel Corporation and the Nova Scotia Steel and Coal Company.

* See Amer. Eng'r., Sept. 1906, p. 334 and Oct., 1910, p. 408.
† 30 Church St., New York, N. Y.

NEW DESIGN THREADING MACHINE

For many years the name Landis has been synonymous with the best and latest practice in threading machines in the minds of master mechanics and shop superintendents. True to this reputation, the Landis Machine Co., Waynesboro, Pa., has recently brought forth several new types of threading machines which possess many unique and valuable features. Three of these shown in the accompanying illustrations demonstrate the success of the efforts of the designers.

Figure 1 shows a ½ in. double head bolt cutting machine in which steel guides instead of cast iron guides, as has been the common practice, are used. The steel guides possess a number of advantages, two being particularly noticeable; they are very accurate to size and possess perfect alignment at all times unless effected by wear after long usage, and when effected by wear they can readily be replaced at a very slight expense; there is no tendency for cuttings to collect on the guides and cause wear. This machine is built with a wide body, with large space for chips, and oil tank in the base separated from chip space by fine screen. The carriage is light yet very strong and easily operated for rapid production. In fact, the whole machine is designed for high speed work and is furnished almost exclusively with high speed steel dies.

In Fig. 2 is shown the new 1 in. high double head bolt threading machine with constant speed motor, silent chain drive, and mechanical speed change device, with a speed range of 3¼ to 1. The motor is mounted on top of the machine out of way of dirt and oil, making the entire equipment very compact and taking up a minimum amount of room. Speed changes can be made while the machine is in operation, and any speed between the maximum and minimum can be acquired quickly. The machine is also adapted for high speed work, and the carriages have adjustment up and down or sidewise for centering to the die, being furnished with either rack and pinion operated carriages or with lever operated carriages.

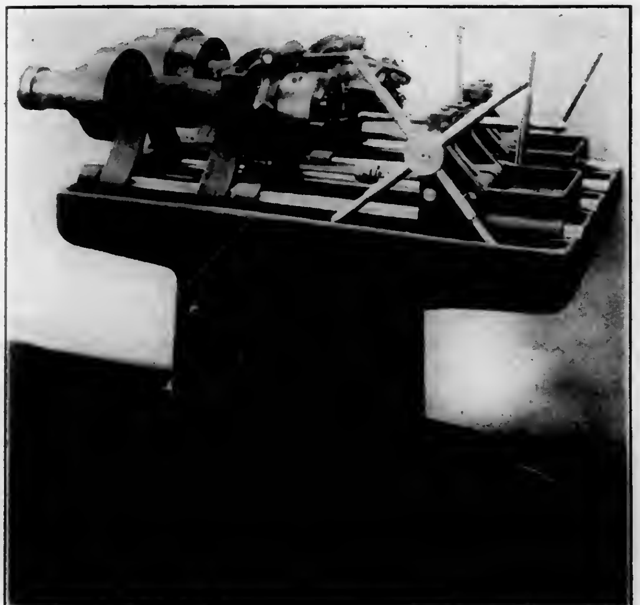


FIG. 1.

The other illustration shows the new 1½-in. motor driven double head staybolt cutter with variable speed motor with speed variation of 4 to 1, so that a very wide range of speeds can be had for taking in any work between minimum and maximum, also making it possible to take advantage of using either carbon or higher speed steel dies, as the case may require. On this machine the motor is mounted on top and in direct connected. This machine is furnished with lead screw attachments for one or both heads, as may be desired, and can be arranged to cut any pitch and diameter within the range of the machine by changing gearing, no extra lead screw being required. All the main spindles are provided with recesses to allow the lubricant to return to the oil tank.

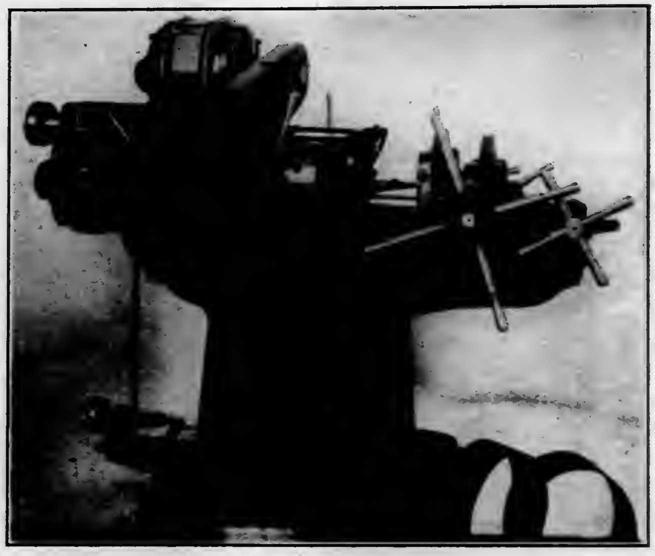


FIG. 2.

On all of these machines the well-known Landis type of die is used and it is held in different manners to suit the different requirements. Two types of chasers can be supplied in this die. In one type the cutter is held by means of a clamp which comes flush with the front edge of the die, so as to admit of cutting close to shoulders or heads of bolts at any time. This is the type of holder used for regular bolt work or for cutting close to shoulders. Dies with very short throats or with no throats at all can be used, and as no grinding is done in the throat of the die when sharpening the throat remains permanent, and this gives a marked advantage on many classes of work.

The other type, known as the mill type, was illustrated on page 376 of the September, 1910, issue of this journal. This clamp is used especially when threading pipe as the clamp comes over the chaser in such a manner as to protect it when the pipe splits or catches the chaser. This clamp is being used in pipe work exclusively on the Landis heads and affords a rigid support

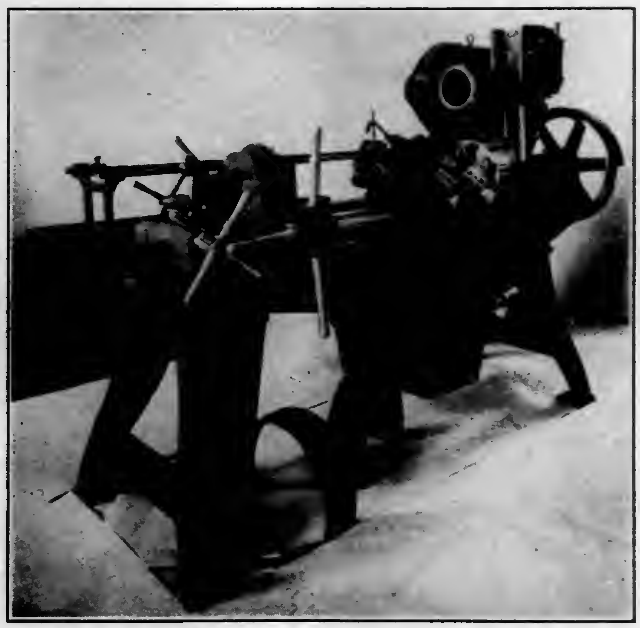


FIG. 3.

motives carrying 200 lbs. gage pressure and having 4,231 sq. ft. of heating surface and $56\frac{1}{2}$ sq. ft. of grate area, and that the maximum steam discharge or evaporation was 2.44 lbs., the minimum 1.18 lbs. and the mean 2.05 lbs. of steam per square foot of heating surface per hour and the committee recommends the following formula providing for safety valve capacity to discharge twice this mean amount, or 4.1 lbs. of steam per hour per square foot of heating surface:*

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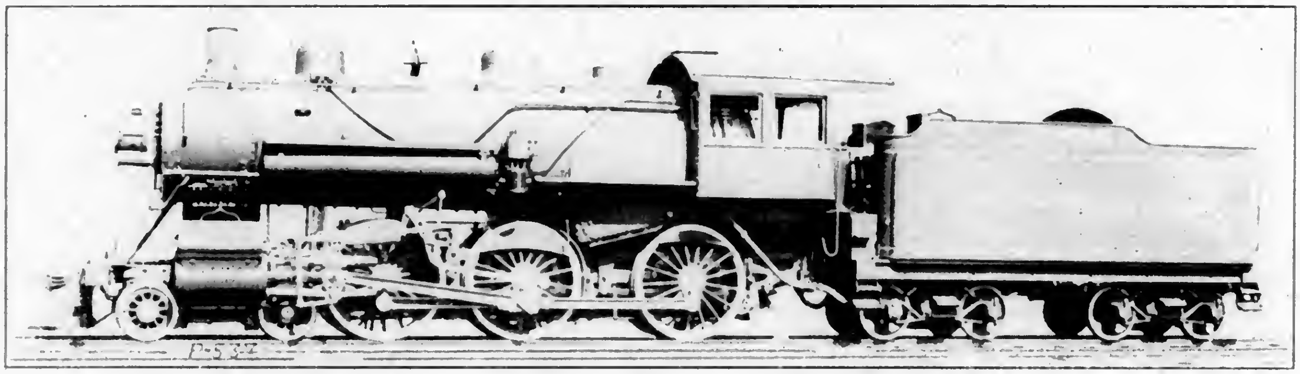
EXPRESS LOCOMOTIVES WITH ALLFREE CYLINDER AND VALVES

PITTSBURGH & LAKE ERIE R. R.

The Pittsburgh & Lake Erie Railroad, one of the New York Central Lines, has had for several years a number of locomotives of different types, equipped with the Allfree system of cylinders and valves, which has been previously illustrated and described in this journal.* These engines are of the 2-8-0 freight, 4-4-0 and 4-6-0 passenger types, and have proved so satisfactory that five additional of the 10-wheel type, as herewith illustrated, have recently been completed at the Pittsburg works of the American Locomotive Company.

The requirements of the Lake Erie passenger service are very severe, and locomotives capable of sustaining great power and speed are a necessity. For instance, from Youngstown, O., to Pittsburg, Pa., 65 miles is made in 90 minutes with stops at New Castle Jn., Beaver Falls, Brighton and Beaver, with a minimum weight behind the tender of 300 tons. On frequent occasions this latter rises to 600 tons, and the average train may be set at 400 tons, irrespective of engine and tender. The road has several grades and a number of high degree curves, in addition to points where speed must be reduced. In consequence, besides the requisite of sustained high speed, rapid



ALLFREE TYPE LOCOMOTIVE FOR PITTSBURGH AND LAKE ERIE R. R.

acceleration becomes imperative. In this class of work the Allfree type of 4-6-0 locomotive has proved all that has been claimed for that system, and duplication of the original design becomes fully consistent.

The new lot of locomotives accordingly reproduce the former order, and to still further enhance their efficiency they have been equipped with the Locomotive Superheater Co.'s† standard fire tube superheaters. This latter feature is probably the most interesting detail in connection with this order as it represents the first application of superheat to the Hobart Allfree valve and cylinder arrangement. A test of these locomotives will no doubt be very closely watched by motive power officials, and inasmuch as the Allfree system has produced very uniform results in fuel economy and in increased hauling capacity, the addition of the superheater, which has been thoroughly tested on the New York Central Lines, should show a very gratifying increase in efficiency.

With these exceptions the new locomotives do not embody any particularly original or novel features. The general design as marked out is very attractive, and may be taken as the best American representative of the 10-wheel type, of which comparatively few have been constructed in recent years.

MORE THAN 1,000,000 TONS OF IRON ORE have been shipped from Bell Island Mines, Newfoundland, this year by the Dominion Steel Corporation and the Nova Scotia Steel and Coal Company.

* See AMER. ENG'R., Sept. 1906, p. 331 and Oct., 1910, p. 408.
† 30 Church St., New York, N. Y.

NEW DESIGN THREADING MACHINE

For many years the name Landis has been synonymous with best and latest practice in threading machines in the minds master mechanics and shop superintendents. True to this putation, the Landis Machine Co., Waynesboro, Pa., has recently brought forth several new types of threading machines hich possess many unique and valuable features. Three of ese shown in the accompanying illustrations demonstrate the ccess of the efforts of the designers.

Figure 1 shows a ½ in. double head bolt cutting machine in hich steel guides instead of cast iron guides, as has been the mmon practice, are used. The steel guides possess a number f advantages, two being particularly noticeable: they are very ccurate to size and possess perfect alignment at all times unless ffected by wear after long usage, and when effected by wear ey can readily be replaced at a very slight expense; there is no ndency for cuttings to collect on the guides and cause wear. his machine is built with a wide body, with large space for ips, and oil tank in the base separated from chip space by fine reen. The carriage is light yet very strong and easily operated r rapid production In fact, the whole machine is designed for igh speed work and is furnished almost exclusively with high eed steel dies.

In Fig. 2 is shown the new 1 in. high double head bolt thread

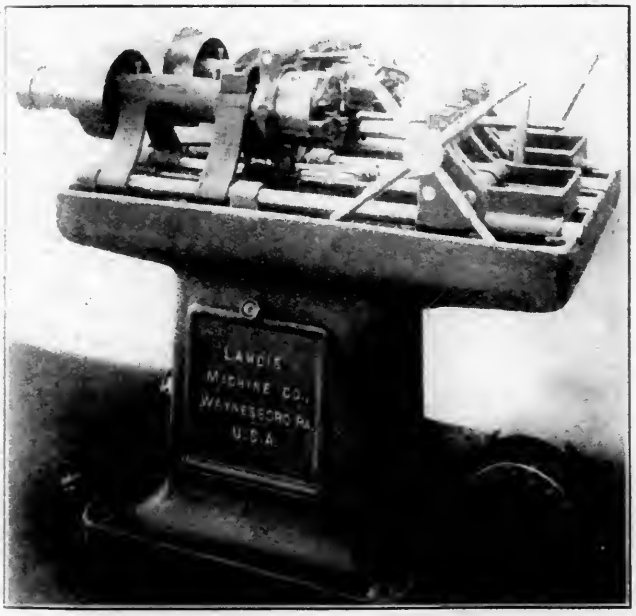


FIG. 1.

ng machine with constant speed motor, silent chain drive, and mechanical speed change device, with a speed range of 3½ to 1. he motor is mounted on top of the machine out of way of rt and oil, making the entire equipment very compact and aking up a minimum amount of room. Speed changes can be made while the machine is in operation, and any speed between the maximum and minimum can be acquired quickly. The machine is also adapted for high speed work, and the carriages have djustment up and down or sidewise for centering to the die, eing furnished with either rack and pinion operated carriages r with lever operated carriages.

The other illustration shows the new 1 in. motor driven double ead staybolt cutter with variable speed motor with speed variation of 4 to 1, so that a very wide range of speeds can be had for taking in any work between minimum and maximum, also making it possible to take advantage of using either carbon or higher speed steel dies, as the case may require. On this machine the motor is mounted on top and in direct connected. This machine is furnished with lead screw attachments for one or both heads, as may be desired, and can be arranged to cut any pitch and diameter within the range of the machine by changing gearing, no extra lead screw being required. All the main spindles are provided with recesses to allow the lubricant to return to the oil tank.

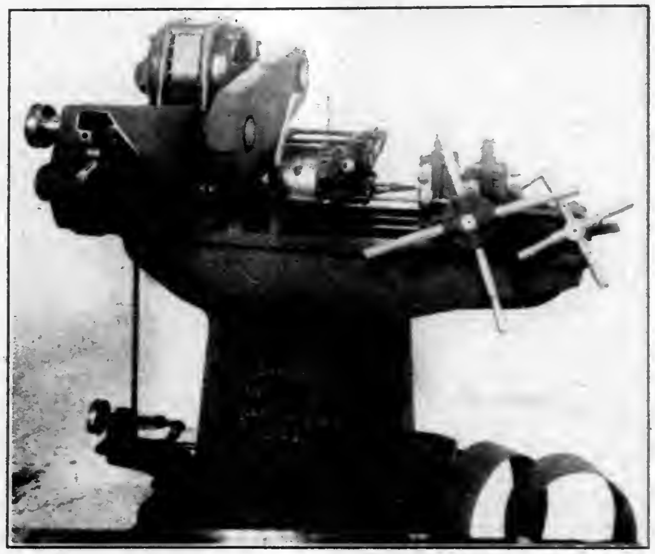


FIG. 2.

On all of these machines the well-known Landis type of die is used and it is held in different manners to suit the different requirements. Two types of chasers can be supplied in this die. In one type the cutter is held by means of a clamp which comes flush with the front edge of the die, so as to admit of cutting close to shoulders or heads of bolts at any time. This is the type of holder used for regular bolt work or for cutting close to shoulders. Dies with very short throats or with no throats at all can be used, and as no grinding is done in the throat of the die when sharpening the throat remains permanent, and this gives a marked advantage on many classes of work

The other type, known as the mill type, was illustrated on page 376 of the September, 1910, issue of this journal. This clamp is used especially when threading pipe as the clamp comes over the chaser in such a manner as to protect it when the pipe splits or catches the chaser. This clamp is being used in pipe work exclusively on the Landis heads and affords a rigid support

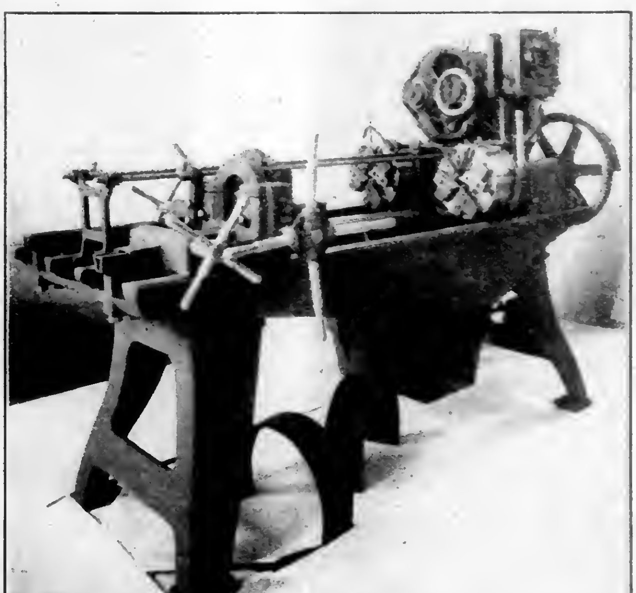


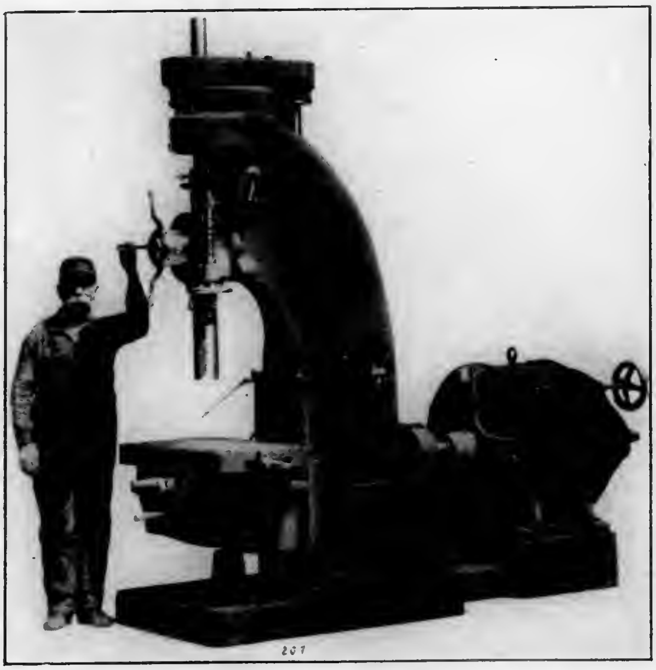
FIG. 3.

to the die. The die holders are made entirely of steel, as are also the die heads on all Landis machines. Any of these machines can be arranged for constant or variable speed motors, as the case may require.

TESTS OF TWIST DRILLS

During the sessions of the recent railway mechanical conventions at Atlantic City the Cleveland Twist Drill Co. gave a demonstration of the quality and work of milled and flattwist drills taken from the regular stock, during which some very remarkable results were obtained in connection with high speed drilling and quantity of material removed.

The demonstration was made on the Foote-Burt No. 25½ high duty drill shown in the illustration. The power and rigidity of this machine are evident from its appearance and the claim of the builders that it has a capacity for high speed drills 3½ in. in diameter in solid steel would not seem to be excessive. In fact these tests proved the quality of the machine as much as it did the drills and the full capacity of neither was reached. The machine has a swing of 36 in. and is driven by a 20-h.p. variable speed motor geared direct through a 2 to 1 reduction. The back gears give a further gear reduction of 2 to 1 and with the variable speeds in the motor the machine has a range of spindle speeds of from 37½ to 600 r. p. m. There are but one set of mitre gears in the whole machine, all others



FOOTE BUST HIGH DUTY DRILL ON WHICH TESTS WERE MADE.

being spur gears, which are always in mesh, the worm gear feeding arrangement of course excepted. Some of the more important dimensions of this machine are as follows: Center of spindle to face of column, 18 in. Maximum distance nose of spindle to top of table, 31½ in. Length of power feed, 16 in. Diameter and length of spindle sleeve, 4½ by 24¾ in. Width of steel rack, 2 in. Vertical adjustment of table, 18 in. Longitudinal adjustment of compound table, 14 in. Cross adjustment of compound table, 8 in. Compound table reduces maximum distance from nose of spindle to top of table 5¾ in. Net weight of machine, 7,000 lbs.

A record for high speed drilling was made during these tests by a 1¼-in. Paragon flattwist high speed drill, which was forced through cast iron at a rate of 57½ in. per minute, nearly an inch per second, the revolutions being 575 and the feed .10 in. Under these conditions it removed 70.56 cu. in. of cast iron per minute. Even this did not reach the limit of strength of the drill, but could not be exceeded because of the inadequate capacity of the electric wires furnishing current to the motor.

Another noteworthy result was in connection with a 2½-in. milled drill, which drilled 68 holes through a billet of machinery steel 4½ in. thick without being reground. This drill was operated at 150 revolutions per minute with a feed of .015 in per revolution and removed a total of 1,418 cu. in. of material. It was still in good condition, but the closing of the conventions concluded the tests.

In the following table is given the results of various tests under different conditions:

Size and Kind of Drill.	Material.	R. P. M.	Feed Per Rev.	Inches Drilled Per Minute.	Peripheral Speed in Feet Per Minute.	Cu. Ins. Metal Removed Per Minute.
1¼ in. Paragon	C. Iron 3½ in..	500	.050	25	163.6	30.68
1¼ in. Paragon	C. Iron 3½ in..	325	.100	32½	106	39.88
1¼ in. Paragon	C. Iron 3½ in..	475	.100	47½	155	58.29
*1¼ in. Paragon	C. Iron 3½ in..	575	.100	*57½	188	70.56
1½ in. Paragon	C. Iron 3½ in..	300	.030	9	117	15.90
1½ in. Paragon	C. Iron 3½ in..	325	.100	32½	127.6	57.43
1½ in. Paragon	C. Iron 3½ in..	335	.100	33½	131.5	59.19
1½ in. Paragon	C. Iron 3½ in..	355	.100	35½	139.4	62.73
1¾ in. Paragon	C. Iron 3½ in..	235	.100	23½	107.6	56.52
1¾ in. Paragon	C. Iron 3½ in..	350	.100	35	160	84.19
2 5/16 in. Paragon	C. Iron 3½ in..	190	.050	9½	115	39.90
3 in. Paragon	C. Iron 3½ in..	120	.100	12	94	84.82
1¼ in. Paragon	Mch. S. 4¼ in..	350	.030	10½	113.7	12.88
1⅝ in. Paragon	Mch. S. 4¼ in..	225	.040	9	94.8	18.66
2 5/16 in. Paragon	Mch. S. 4¼ in..	165	.020	3¼	100	13.65
2 5/16 in. Paragon	Mch. S. 4¼ in..	200	.020	4	121	16.80
2½ in. Milled	Mch. S. 4¼ in..	150	.015	2¼	98	11.04
2½ in. Milled	Mch. S. 4¼ in..	150	.040	6	98	29.45
2½ in. Milled	Mch. S. 4¼ in..	175	.040	7	114.5	34.36
1¾ in. Paragon	Mch. S. 4¼ in..	275	.030	8¼	125	19.84
3 in. Paragon	Mch. S. 4¼ in..	150	.030	4½	117.8	31.81
3¼ in. Paragon	Mch. S. 4¼ in..	150	.030	4½	127	37.33

It will be seen that a number of these tests are at speeds and feeds which would be economical under average shop conditions, while others are more or less in the nature of "stunts" to show the reserve power of the drills, as well as the great rigidity of the machine and its uniform driving power.

THE CANADIAN PACIFIC RAILWAY is one of the most extensive users of telephone train dispatching on this continent. Its experience is so satisfactory that it has just placed an order with the United States Electric Company of New York and Chicago for 187 additional Gill Selectors on its lines East and 68 additional for its lines West, one selector to a station. Other orders recently for the Gill Selector are 74 stations for the Seaboard Air Line, a pioneer among the Southern roads in telephone train dispatching, and 88 stations for the Atlantic Coast Line.

PROGRESS ON THE EXTENSION TO CONNELLSVILLE, PA.—It has been announced that the last rail on the Western Maryland Railroad extension from Cumberland, Md., to Connellsville, Pa., where it will connect with the Pittsburg and Lake Erie, would be laid not later than August 1. Two months later the company expects to be operating through trains to Pittsburg over the extension and the Pittsburg and Lake Erie roads.

THE PENNSYLVANIA RAILROAD has for some time been conducting a campaign in the interests of good roads. Literature has been disseminated and lectures have been given in a number of towns. The company has announced its desire to do everything in its power to improve the roads radiating from its stations in order that they may be kept open during the winter months, thereby facilitating the movement of freight to and from the stations.

IT IS NOT SAFE TO CONCLUDE that those employers who have had the experience and the profit will be convinced that the most ethically conducted business is the most profitable; that business ideals must be ethical ideals.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

* This is the highest drilling speed on record.

A STUDY OF THE VENTILATION OF SLEEPING-CARS*

THOMAS R. CROWDER, M.D.

Problems of ventilation confront the designers and operators of all enclosed spaces in which one or more persons are expected to live. Demands for a supply of fresh air must be recognized by those operating hospitals, theaters, offices and to a peculiar degree by those concerned in the management of public conveyances, in which the space for each occupant is necessarily restricted. For the purpose of securing a suitable exchange of air in railway cars many types of ventilators have been suggested and not a few have been given practical tests. About three years ago I was asked to report on the efficacy of one of these which had been applied to a few sleeping cars, which has since been applied to a large number, and which seemed to be of considerable practical usefulness.

In this connection it became evident that it would be necessary to establish some basis of comparison, since it does not seem to have been estimated in exact figures to what degree natural ventilation of a railway car is effective. Inasmuch as the problem is one of lasting importance and is likely to recur, it seemed advisable to make a fundamental study of the question and to place the results within reach of those who might have occasion to make use of them.

A very simple, if somewhat tedious, means of making this investigation was long ago established by Pettenkofer. It consists of estimating the vitiation of the atmosphere by determining the amount of carbon dioxid it contains, and from this computing the amount of air supplied for ventilation.

All air contains carbon dioxid as a normal constituent. The average amount in pure air is commonly stated to be 4 parts in 10,000. This is the figure arrived at by Pettenkofer and the one generally used in ventilation computations, though recent investigation has shown it to be a little too high. Harrington considers the normal as but slightly in excess of three. It varies at different times and places, but the variation is confined within very narrow limits. It is somewhat higher in cities than in the open country. The average for fifteen samples, which were collected in the country districts of Illinois in 1907, was 3.6, with a maximum of 4; for thirty-nine samples from the streets of Chicago during the same period the average was 4.06 with a maximum of 5.

The carbon dioxid in the expired breath averages more than 4 per cent. (400 in 10,000). The amount excreted hourly varies according to age, sex and the degree of bodily activity. In a mixed community of persons at rest it will average about 0.6 cubic feet per person per hour, and the variation will be a small one.

If there were no ventilation whatever the air of an ordinary railway coach, containing 4,000 cubic feet of space and occupied by twenty people, would have 34 parts of carbon dioxid per 10,000 of air at the end of one hour of occupancy; and this would continue to increase indefinitely in a direct ratio to the time, since carbon dioxid continues to be produced by the respiration of the occupants at a practically constant rate. But no car is air-tight, consequently the carbon dioxid will never reach this theoretical limit. Fresh air from the outside is constantly entering through the numerous crevices about the doors and windows, and old air is constantly leaving. The inside air is being constantly diluted.

It is plainly impossible to measure directly the amount of air flowing into a car, since it enters at many points and at constantly changing velocities. But the amount of the interchange may be readily computed from the actual amount of carbon dioxid found from time to time by applying the figures given above to a simple mathematical procedure. To illustrate this problem: Suppose a car contains twenty people and its atmosphere is found to have an average of 10 parts of carbon dioxid per 10,000. The incoming fresh air contains 4 parts of carbon dioxid per 10,000, hence the respiratory contamination of the car air is represented by only 6 parts. Twenty people produce twenty times 0.6 cubic feet, or 12 cubic feet of carbon dioxid per hour. With what amount of air must 12 cubic feet of carbon dioxid be diluted so that the air will contain 6 parts of carbon dioxid in 10,000? The simple proportion, 6 : 10,000 :: 12 : ?, gives 20,000 as the answer. Hence there must be 20,000 cubic feet of air supplied per hour, or 1,000 cubic feet for each person present, in order sufficiently to dilute the carbon dioxid produced so as to maintain its proportion at 10 parts in 10,000. The computation is better represented by the general formula:

$$A = vp \div (x - N)$$

where v = the CO_2 produced by one person (cu. ft. per hour),
p = the number of persons in the room.
x = the proportion of CO_2 found in the air of the room,
N = the proportion of CO_2 in the outside air (0.0004),
and A = the air-supply to the room (cu. ft. per hour).

By applying the above calculation to the conditions supposed —a room containing twenty people—we find that with the carbon dioxid at 0.0009, or 9 parts per 10,000, 24,000 cubic feet of air, or 1,200 cubic feet per person, would be necessary; at 0.0008, 30,000, or 1,500 cubic feet per person; at 0.0007, 40,000, or 2,000 cubic feet per person, at 0.0006, 60,000, or 3,000 cubic feet per person; at 0.0005, 120,000, or 6,000 cubic feet per person; at 0.00045, 240,000, or 12,000 cubic feet per person; and at 0.0004 an infinite amount per room and per person.

The first attempt to apply Pettenkofer's methods to the air of railway cars and to place our knowledge of their ventilation upon a scientific basis seems to have been made by Wolfhügel and Lang in 1875. Further investigation was carried out under the direction of the Prussian minister of war in 1887-8, in order to determine the best means of ventilating military hospital cars.

Some fifteen or twenty years ago a number of analyses of the air from passenger cars were made by Professor Nickols, working under the auspices of the Board of Railroad Commissioners of the State of Massachusetts. About the same time the Pennsylvania Railroad Company took up the subject and had a few tests made. In 1894 a committee of the Master Car Builders' Association made a somewhat extensive report on the subject of car ventilation, and with it submitted the results of several analyses of the air from sleeping-cars, chair-cars and suburban coaches. Eight observations in sleeping-cars, with an average of 12.5 passengers, gave an average of 18 parts carbon dioxid per 10,000. The highest was 22, the lowest 11.3. Eight observations in chair-cars, with an average of 17.4 passengers, gave average carbon dioxid of 10.7 parts per 10,000; highest 15.5, lowest 7. Six observations in suburban coaches, which are stated to have been one-half to two-thirds full, averaged 13.8 carbon dioxid per 10,000; highest 21.7, lowest 6.9. No record of the conditions under which the samples were taken or of the methods employed are given. It is not stated whether the cars were moving or standing still at the time the observations were made.

In 1904 Dudley reported on a part of some thirty or forty analyses made of the air of cars of the Pennsylvania Company, which were ventilated by the excellent system which he devised. He found from 10 to 18 parts of carbon dioxid per 10,000 in running cars, and 20 to 21 parts in cars standing still for twenty minutes. Fifty-two people occupied the cars, and are assumed to have produced 0.72 cubic feet of carbon dioxid each per hour; from which is estimated 26,000 to 62,000 cubic feet of air-supply per hour for the moving and 22,000 to 23,000 for the still cars.

Numerous reports are to be found upon particular types of ventilators and ventilation systems as applied to railway cars. An excellent and extensive report of this order was made by a committee of the Master Car Builders' Association, in 1908, in which the various systems in general use were reviewed in detail. But unless I have missed important literature on this subject, the information concerning the actual conditions of the air in railway cars is very meager. It is adequate on the application of ventilating devices, but there is no series of analyses extensive enough on which to base any comprehensive opinion as to the deficiencies of natural ventilation to be overcome, or as to the adequacy of the devices applied in keeping the air of the breathing-zone freed from the products of respiration.

The ventilating device* upon which this report is based is designed to remove air by exhaustion from the upper portion of the car, and its operation is dependent on train motion. It was easily determined that it does exhaust air in this way. A long series of anemometer readings, made chiefly by Mr. C. S. Knapp, have shown that each such exhaust ventilator will remove an average of about 15,000 cubic feet of air per hour at a forty-mile train speed, and proportionately more or less for faster or slower speeds. While there is considerable variation under apparently similar conditions, the outward flow is a constant one. One ventilator is placed over each alternate section of a sleeping-car; thus there are six in the sleeping-compartment of the ordinary twelve-section car and eight to a sixteen-section car, while two are applied to the smoking-room and one to a stateroom. Toilet and dressing-rooms are also equipped with one each in recent practice. It is readily seen that a very large volume of air leaves the car each hour through these openings; it must enter somewhere. The question was, does it enter at such places and take such courses as to cause a free dilution of the air at the breathing level in the occupied car? There seems no adequate way to answer this question except by determining the carbon dioxid in such air, from which the amount of dilution may be computed as already indicated. It was desirable also to make determinations in cars not having the exhaust ventilators, but depending upon natural ventilation, for purposes of comparison.

The results of such determinations, while applying particularly to the specific ventilator in use, are to be considered rather as a test of the type—ventilation by exhaustion—as applied to railway cars, and may apply equally to any exhaust ventilator placed in the same location, provided only that the one used

* Presented at the thirty-eighth annual meeting of the American Public Health Association, Milwaukee, September, 1910.

* The ventilator referred to, known as the Garland Ventilator, is furnished by Burton W. Mudge & Co., Chicago.

actually accomplishes its purpose of removing air in large volume and with constancy.

METHODS.

Determinations of carbon dioxid were made by the Petterson-Palmquist apparatus, with a pipette of 20 c.c. capacity. This instrument furnishes a direct volumetric reading of carbon dioxid and should be sensitive to one part in 20,000 of air when carefully used. The accuracy of the method has been amply proven by Teich and others.

About a thousand c.c. of the air to be examined was pumped into a large rubber cautery bulb, arranged with a cut-off, and was then emptied into a two-ounce bottle through a delivery tube leading to the bottom. The bottles were fitted with well-ground glass stoppers, lightly coated with petrolatum, and were immediately sealed after filling with the samples, by pressing the stopper tight and turning it around until no air channels were visible in the petrolatum.

If an average sample of the air was desired, the bulb was filled while walking up and down the middle portion of the car; if of a single place the bulb was filled in place or the air simply pumped through the bottle by means of a small hand bellows. For taking air from an occupied berth a woven tube about 14 inches in length and possessing enough stiffness to stand alone was passed its full length between the curtains into the berth, and air was withdrawn through this into the bottle. The delivery of air was into the bottom of the bottle, the old air being drawn off from the top by suction. Experiment showed that withdrawing through the bottle ten or twelve times the volume of air originally in the container always furnished a fair sample of the air to be tested. The point from which the berth air was taken lies approximately twelve inches behind the middle of the curtain. Comparative determinations from different points in the same berth have shown that this represents a fair sample of the berth air.

The samples of air collected in this manner were opened under a saturated solution of pure sodium chlorid, which had been saturated with carbon dioxid in order to remove any trace of free alkali and exposed to the air. The mouth of the bottle was closed by the finger-tip; it was then removed from the solution and the finger replaced by a rubber stopper, through which a similar solution was immediately let into the bottle from a siphon. This forces the air out through a second very narrow rubber tube about 10 inches in length; and when the whole of the original air contained in this tube is displaced it may be connected to the pipette of the instrument and the air let in for analysis. There is no doubt a trifling interchange of gases between the outside air and that contained in the sampling bottle during the insertion of the rubber stopper; but with the equalized pressure brought about by opening the container under salt solution the change is so slight as to be undetectable and therefore negligible. Saturated salt solution is so slightly absorbent for carbon dioxid that no appreciable error is occasioned by the short time of exposure involved in this procedure.

When the air samples were taken from the cars a record was entered opposite the identifying numbers assigned to them, in which was recorded the date, line, time of day, time of occupancy, name of the car, its distance in car lengths from the locomotive, approximate speed, the place taken, the outside and inside temperature, the direction of the wind, number of passengers, whether doors, windows or decks were open, or whether the exhaust ventilators were used, the kind of lighting; and remarks were added as to the comfort, apparent ventilation, etc. Samples were collected chiefly in the course of ordinary travel, and, in general, no attempt was made to control any of the arrangements, the purpose being to study actual and general conditions as they exist normally.

All of the observations were made during the cooler months of the year, and nearly all when the outside temperature was low. This varied from below zero to 65° F., being in the majority of instances below 40° F.

The larger proportion of observations were made during the night after passengers had retired, and practically every hour of the night is represented by different parts of the work. This was necessary in order to study the chief feature of the sleeping-car, namely, the occupied berth.

Nearly 3,000 carbon dioxid determinations were made for all purposes in connection with this work; about 2,000 of these were of the air from over 200 sleeping-cars. A considerable number were made of the air of day coaches, suburban cars, street-cars, stores, restaurants, offices and the open air for comparative purposes, and others for the purpose of establishing certain facts experimentally.

RESULTS.

Before proceeding to an analysis of the findings it is necessary to know the amount of carbon dioxid in the air surrounding trains in order to have some basis for computing air-supplies to cars. The locomotive emits an enormous total volume of this gas, which, it is easily conceived, might play a considerable part in the amount of carbon dioxid found in the air of the cars. According to Leissner the air surrounding trains contains from 18 to 22.8 parts carbon dioxid per 10,000. My results are at variance with this. Forty-six determinations averaged 4.04; the highest was 10, the lowest 3. A few showing 5 and over were made from the rear platform of trains running in a straight head wind, where the suction effect of the advancing body has a tendency to draw in the overhanging gases. One sample showing 10 and one showing 7.5 were taken in closed vestibules, which generally show no internal contamination. It is a matter of ready observation that any lateral wind carries all the smoke from a locomotive stack well out of the path of the following train. Presumably this is true of the invisible gases as well as the visible carbon. When the wind is straight ahead or directly with the train, the smoke and steam are, as a rule, carried high enough by their propulsion from the stack and their heated condition to allow the train to pass under with a clear interval, the heavier particles only, such as the small cinders, falling in its path. Of course, the smoke and condensed steam do not diffuse as do the invisible gases; but with these is mixed a quantity of sulphur dioxid, for which the sense of smell is very delicate. My observation has been, in the examination of tunnel air, that where flue gases have contaminated the air with 15 to 20 parts of carbon dioxid in 10,000, sulphur dioxid is readily detected. It occasionally happens that sufficient gas is carried into a train running in the open to render sulphur dioxid noticeable. It seems that my determinations of carbon dioxid in the air surrounding trains have not dealt with the conditions that could bring this about. Consequently I conclude that this is a relative rarity, and that 4 in 10,000 is a proper average to deal with in considering the air outside of moving trains. Undoubtedly trains may run for a long distance and be surrounded by only the pure air of the open country, containing not more than 3.5 parts of carbon dioxid per 10,000. It must be realized that conditions may change almost momentarily.

It was not found feasible to make use of all the items recorded at the time of collecting the samples in the analysis of the findings. The distance of a car from the engine appears to bear no definite relation to the amount of carbon dioxid in its atmosphere; the direction and force of the wind is so difficult to follow, especially at night, that it must generally be neglected; a car nearly always contains more carbon dioxid before starting than after it is in motion, so the length of time of its service becomes negligible; the products of illuminating gas combustion are carried out directly through the roof of the car and play no part in the air contamination; a low outside temperature is compensated for by more internal heat and seems to make no constant difference in the air-supply; the actual train speed is of less importance than the relative, that is, the rate and angle at which it cuts the wind.

It was soon observed that a few open windows in a moving train admit such a volume of the surrounding air as to render the respiratory contamination almost undetectable.

So we may dismiss the car with open windows from further consideration, and with it the whole subject of summer ventilation, in so far as the term "ventilation" refers to supplying air and not to keeping the car cool, and turn to the car running in cold weather and with windows closed.

As already intimated, two main types of ventilation will be dealt with: the so-called natural ventilation of cars which are not equipped with any special ventilating devices, and ventilation by exhaustion with the device referred to in a previous section. All examinations were made at the ordinary breathing level unless otherwise stated. The computations of air-supply, or of ventilation efficiency, refer then to the air dilution in this breathing-zone, and to the main compartment of the car.

NATURAL VENTILATION.

The most ordinary condition for the natural ventilation of cars in cool weather is to have the doors and windows closed and a certain proportion of the small windows at the top of the car open. These small windows are herein referred to as "decks" or "deck sash," in order to avoid confusion of the term "window," which will always refer to those along the sides of the car, and of the term "ventilator," which will refer to the exhaust ventilator above mentioned.

From 153 observations made in 44 cars under these conditions the average carbon dioxid was 7.19 per 10,000. The maximum is 13, the minimum 3.5. The average number of passengers for the 153 observations is 15.05. A car carrying this number of people would require 28,300 cubic feet of fresh air hourly to maintain the carbon dioxid at 7.19 parts per 10,000. In other words, there would necessarily be an air supply of 1,880 cubic feet per person hourly.

Adding to the open decks by opening one or both end doors to the vestibule (the outside vestibule doors remaining closed) would be expected to cause a greater air-supply. Such is the case, as was shown by forty-six observations.

The maximum carbon dioxid is 8.5 against 13, while 64.35 per cent. of the determinations are below 6. The average carbon dioxid being 5.40 per 10,000 and the average number of passengers 9.50, there would be required 40,700 cubic feet of air hourly to meet the conditions. It sometimes happens that an

end door is open and practically no air enters through it; on the other hand, an enormous volume may enter; and occasionally air may leave the body of the car through such an open door. These are facts which may be verified by noting the direction and force of the air currents as they pass. Air does not necessarily sweep through cars with doors open to the vestibules, though on the average the air supplied to the breathing-zone in the body of the car is considerably increased. There seems to be no constancy as to which door acts best in the capacity of ventilator. Sometimes the forward and sometimes the rear is most efficient.

Only twelve observations were made where both doors and all of the deck sash were closed. Whatever amount of the outside air enters the car under these conditions must find its way in through natural crevices and is driven in and out by the pressure of the wind and the suction effects produced by the motion of the train

As would be expected under these conditions, the average carbon dioxid is greater than in either of the preceding groups and the computed air-supply is smaller. The maximum carbon dioxid has advanced to 15, while the average is 8.33. Eight and three-tenths per cent. are above 12 and 33.3 per cent. are above 8, while only 16 6 per cent. are below 6. With the average of 8.33 parts of carbon dioxid per 10,000 and 13.33 passengers 18,500 cubic feet of air per hour would be required.

There were only two observations made when all the decks were closed and one end door to the vestibule was open—the rear door in each instance. The number of passengers averaged 9.5 and the carbon dioxid averaged 5.75, which would indicate a ventilation efficiency equivalent to 32,500 cubic feet of air per hour. The number of observations is too small to have any considerable value.

The comparative efficiency of natural ventilation in the four groups of conditions stands: 18,500 cubic feet of air hourly for the fully closed car; 28,300 when from one-fourth to all the decks are open; 32,500 when decks are closed and one door open; and 40,700 where end doors are open in addition to open decks. It is, of course, possible that a larger number of observations would materially change these figures, but it is not probable that their relation to each other would be greatly altered.

VENTILATION BY EXHAUST VENTILATORS.

It has been stated that one ventilator of the type described is fitted above each alternate section of sleeping-cars and that each ventilator will remove an average of 15,000 cubic feet of air per hour at a forty-mile train speed. No special intakes are provided for this air. It goes out; it must come in. But it might come in at such places and take such courses as to play no part in aerating the breathing-zone of the car—might be short-circuited, so to speak. The results of the carbon dioxid determinations of air at the breathing level shows that to a certain extent this must happen, since the air supplied to the breathing-zone, as computed from carbon dioxid determinations, is considerably less than the amount which leaves through the ventilators, as determined by actual measurement. But in spite of this the air-supply is much increased and is better regulated than in cars not so equipped.

Two hundred and ninety-four determinations in 67 cars which were fitted with these ventilators and in which all doors and windows were closed were recorded.

As in the case of natural ventilation, there is here also a considerable variation in the computed air-supplies, though the tendency is to much more pronounced uniformity. The maximum carbon dioxid is 10 parts per 10,000 of air, the minimum 4.5 parts. The average carbon dioxid is 6.20 per 10,000 and the average number of passengers 14.88. There would be required 40,600 cubic feet of air hourly to satisfy these conditions. Of the 294 determinations of carbon dioxid only 4.4 per cent. are over 8 per 10,000 while 46.9 per cent. are below 6 and 95.6 per cent. are as low as 8. Hence the ventilation efficiency is equivalent to at least 1,500 cubic feet per person hourly 95.6 per cent. of the time and is 3,000 cubic feet or more 46.9 per cent. of the time, while it is never less than 1,000 cubic feet.

It will be noticed that the averages of the totals in this table represent essentially the same average ventilation as for those where to a proportion of open decks is added an open door. Probably its proper comparison would be made with the conditions of the first tests noted, when it is seen that there is a distinct advantage in favor of the cars equipped with exhaust ventilators over those ventilated by the decks, and that this advantage represents an average addition in the air-supply to the breathing-level of about 12,000 cubic feet of air per hour.

Forty-eight observations in twelve cars equipped with ventilators and having one or both doors open to the vestibules were recorded.

With an average of 14.48 passengers the carbon dioxid varies from 3.5 to 9, and averages 5.50. It is over 8 but once and is 29 times under 6 (60.4 per cent.). While the totals and average carbon dioxid are very close to those where natural ventilation is carried on through open decks and doors, the number of passengers is greater and the equivalent air-supply is 57,900 cubic feet per hour against 40,700, showing again a distinct advantage in favor of the cars equipped with exhaust ventilators

For the cars depending upon natural ventilation the general averages of passenger and carbon dioxid for all observations are 13.70 and 6.88, respectively, and the equivalent hourly air-supply 28,500 cubic feet. Averaging all observations in cars when there were—

Less than 10 passengers: 7.48 and 5.91, respectively; equivalent air-supply = 23,500 cu. ft. per hour.

Between 10 and 15 passengers: 13.29 and 6.62, respectively; equivalent air-suppply = 30,500 cu. ft. per hour.

Between 15 and 20 passengers: 17.57 and 7.38, respectively; equivalent air-supply = 31,200 cu. ft. per hour.

More than 20 passengers: 23.18 and 8.85, respectively; equivalent air-supply = 28,700 cu. ft. per hour.

For cars equipped with exhaust ventilators the general averages of passengers and carbon dioxid for all observations are 14.82 and 6.11, respectively, and the equivalent hourly air-supply 42,100 cubic feet. Averaging all observations in these cars when there were—

Less than 10 passengers: 9.10 and 5.58, respectively; equivalent air-supply = 34,600 cu. ft. per hour.

Between 10 and 15 passengers: 13.51 and 5.95, respectively; equivalent air-supply = 41,600 cu. ft. per hour.

Between 15 and 20 passengers: 17.65 and 6.46, respectively; equivalent air-supply = 43,000 cu. ft. per hour.

More than 20 passengers: 23.24 and 7.24 respectively; equivalent air-supply = 43,000 cu. ft. per hour.

THE BERTH.

When taking samples of air from the berths in the manner already described, it was the rule to take, as nearly simultaneously as possible, an average sample from the aisle for comparison. Samples from each place were generally repeated at fifteen-minute intervals, until twenty or more had been collected in the car. Two lower berths on each side of the car were generally selected, availability determining the choice, and one or two uppers when possible.

In testing sleeping-cars not fitted with exhaust ventilators, the average carbon dioxid for all berths is 8.32 and the average ventilation is equivalent to 1,389 cubic feet of air per hour per berth. The lowest average carbon dioxid for the berths of any car is 6.41, the highest is 9.78; inversely, the largest equivalent air-supply is 2,473 cubic feet per hour, and the smallest is 1,038 cubic feet per hour. Of the 321 determinations of carbon dioxid 1.2 per cent. are above 12 per 10,000; 11.2 per cent. are above 10; 44.5 per cent. are above 8; only 2.5 per cent. are below 6, and 55.5 per cent. are 8 or under. Hence, 55.5 per cent. of the determinations indicate that at the moment the samples were taken the air of the berth was diluted with fresh air to an extent that would necessitate ventilation of that berth with 1,500 or more cubic feet of air hourly; it was less than 1,500 feet per hour in 45.5 per cent., less than 1,000 cubic feet in 11.2 per cent., and less than 750 cubic feet in only 1.2 per cent. of the examinations.

If a considerable number of the upper berths are occupied the car is necessarily well filled. The higher number of passengers would logically account for a higher carbon dioxid in the body of the car (average 20.51 passengers and 8.37 carbon dioxid against 16.41 passengers and 7.32 carbon dioxid in the table for lower berths). With open decks it would be expected to find better ventilation in the upper part of the car. On the other hand, when the decks are closed the opposite may be the case.

Of the 41 determinations of carbon dioxid 9.8 per cent. are above 12; 19.5 per cent. above 10; 61 per cent. above 8; 2.4 below 6; and only 39 per cent. are 8 or under. These figures indicate that the ventilation of these berths was equivalent to 1,500 cubic feet or more of air hourly in 39 per cent., less than 1,500 cubic feet hourly in 61 per cent., less than 1,000 cubic feet in 19.5 per cent., and less than 750 cubic feet in 9.8 per cent., while the average ventilation is equivalent to 1,161 cubic feet per berth per hour.

Of 39 times that the comparison can be made the air of the berths contains less carbon dioxid than the aisle at the same time in 17.9 per cent.; it contains more in 61.5 per cent., and they are equal in 20.5 per cent.

Comparison of Lower and Upper Berths in Same Car.—I am able to compare the carbon dioxid, consequently the ventilation, of the lower and the upper berths in five cars.

In two cars there is less carbon dioxid in the air of the lower berths than in the uppers; consequently, the ventilation of these lowers is better than that of the uppers. In the remaining three cars the carbon dioxid is lower in the uppers; consequently, the ventilation of the upper berths is more efficient than for the lower berths in the same cars. There was a total of 91 determinations for the lower berths of these cars, against 34 for the upper berths. The average of these totals gives slightly less carbon dioxid for the lowers than for the uppers; consequently, there was a slightly better average ventilation of the lowers under the conditions represented than of the uppers.

Simultaneous determinations were made for the lower and upper berth of the same section thirty-four times in these cars. The upper had more carbon dioxid than the lower 20 times (58.8 per cent.) less 8 times (23.5 per cent), and they were

equal 6 times (17.7 per cent.). The relative ventilation is, of course, inversely as the carbon dioxid.

Six hundred and ninety carbon dioxid determinations of the air of lower berths and 53 of the air of upper berths in cars equipped with exhaust ventilators showed that in all but three of the forty-two cars (17, 31 and 37) the average carbon dioxid of the lower berths is higher than the average for the aisle. The average difference for all observations is 0.63 parts per 10,000 of air. The highest for the aisle is 10, the lowest 4.5; for the berths the highest is 13.5 and the lowest 4.5. In 20.4 per cent. of the berths the carbon dioxid is lower than the aisle at the same time; in 63.8 per cent. it is higher than the aisle, and in 15.8 per cent. they are equal.

The average carbon dioxid per berth is 6.96 per 10,000; the average ventilation is equivalent to 2,027 cubic feet per hour. The lowest average carbon dioxid for the berths of any car is 5.38, the highest is 9.34; the largest equivalent air-supply is 4,348 cubic feet per hour, and the smallest 1,123 cubic feet per hour. Of the 690 determinations of carbon dioxid only one, 0.14 per cent. is above 12 parts per 10,000; 3.3 per cent. are above 10; 21.7 per cent. are above 8; 24.5 per cent. are below 6, and 78.3 per cent. are 8 or under. Consequently the ventilation is equivalent to more than 3,000 cubic feet of air per berth hourly in 24.5 per cent. of the berths examined; it is 1,500 or more in 78.3 per cent., and less than 1,500 cubic feet in 21.7 per cent.; it is less than 1,000 cubic feet per hour in 3.3 per cent. and less than 750 cubic feet but once in 690 determinations. In this case 631 cubic feet is indicated.

Of the 53 determinations of carbon dioxid in upper berths the highest is 10.5, the lowest 4.5. There is but one over 10 (2 per cent.); 17 per cent. are over 8; 32 per cent. are below 6, and 83 per cent. are 8 or under. The ventilation is therefore equivalent to more than 3,000 cubic feet per hour in 32 per cent.; it is 1,500 cubic feet or more in 83 per cent.; 1,000 cubic feet or more in 98 per cent., and less than 1,000 in 2 per cent., while the average ventilation is equivalent to 2,222 cubic feet per hour. The berth is higher than the aisle at the same time in 94.3 per cent. and lower in 5.7 per cent.

It seems clear that the average ventilation of the lower berth in this type of car is on the average slightly better than the upper, but the difference is so small as to be of no practical consequence.

In a general way it is found that the average of the berths and of the aisle follow each other consistently. Both vary from time to time in a way that can be only theoretically explained, and an individual berth may show great irregularity.

If we bring into comparison the conditions of the two classes of cars, those without and those with the exhaust ventilators, a decided advantage is seen to lie with the latter in the study of berth conditions, as was before noted in the study of air from the car body. It was possible in only two instances to make direct observations of the comparative ventilation in these two classes of cars under identical conditions by taking samples of the air simultaneously from the two on the same train. The results are shown in Chart I. It will be noticed that the averages lie a considerable distance apart and represent a greater air-supply to the cars with exhaust ventilators in both instances.

THE ENTRANCE AND DISTRIBUTION OF AIR.

It has been shown that an average of over 40,000 cubic feet of air per hour enters the breathing-zone of sleeping-cars equipped with the type of exhaust ventilator herein considered. It has been further shown that approximately twice this much air leaves from the upper portion of the car through the six or eight ventilators used. In the absence of specific intakes it is difficult to determine exactly in what manner this air finds an entrance.

Sleeping-cars are snugly built; the crevices are small; but no crevice is too small to admit air, provided a little pressure is behind it. A row of windows covers each side of the car, another row of small ones extends along each side at the deck level, and each end has a door. There is a sum total of approximately 500 lineal feet of crevices at their edges. If they average one-fiftieth of an inch in width and admitted air at half the rate of the train speed, the 40,000 cubic feet would be more than accounted for. Some of these crevices are much larger than one-fiftieth of an inch, some are probably smaller. It is not unusual to find air entering certain areas of open windows at a rate equal to one-half the train speed, or even more. The crevices may act in the same way; the passage of air through such invisible openings is a much more important means of ventilation than might be thought. Pettenkofer showed that when all visible chinks were closed in a room the rate of ventilation was decreased only 28 per cent. as compared with the rate when the doors were closed in the ordinary way. Putnam showed that air entered a room through a register almost as rapidly when every means was taken to make it air-tight as when the doors stood open. There is no difficulty with the draught of an open fireplace when the room is closed, though each pound of coal consumed causes some 2,600 cubic feet of air to pass up the flue.

Samples of air were taken simultaneously from various locations in sleeping-cars with exhaust ventilators and the carbon dioxid determined, in an attempt to find where the contamination is greatest. So long as the samples are taken well within the body of the car they show nearly uniform results for different levels and different locations; hence the general mixing of the air must be good. The carbon dioxid is, on the average, a little lower close to the floor than higher up. This is consistent with the upward trend of the flow to the ventilator exits. There is essentially no difference between the breathing-zone and the bell-cord level. There is a slight difference between samples taken at the breathing-level and near the ventilator exits, the latter being lower; but the difference is not so great as would be indicated by the difference in the dilution of the lower air and the amount leaving the car through these exits.

The one way in which strikingly different comparative results

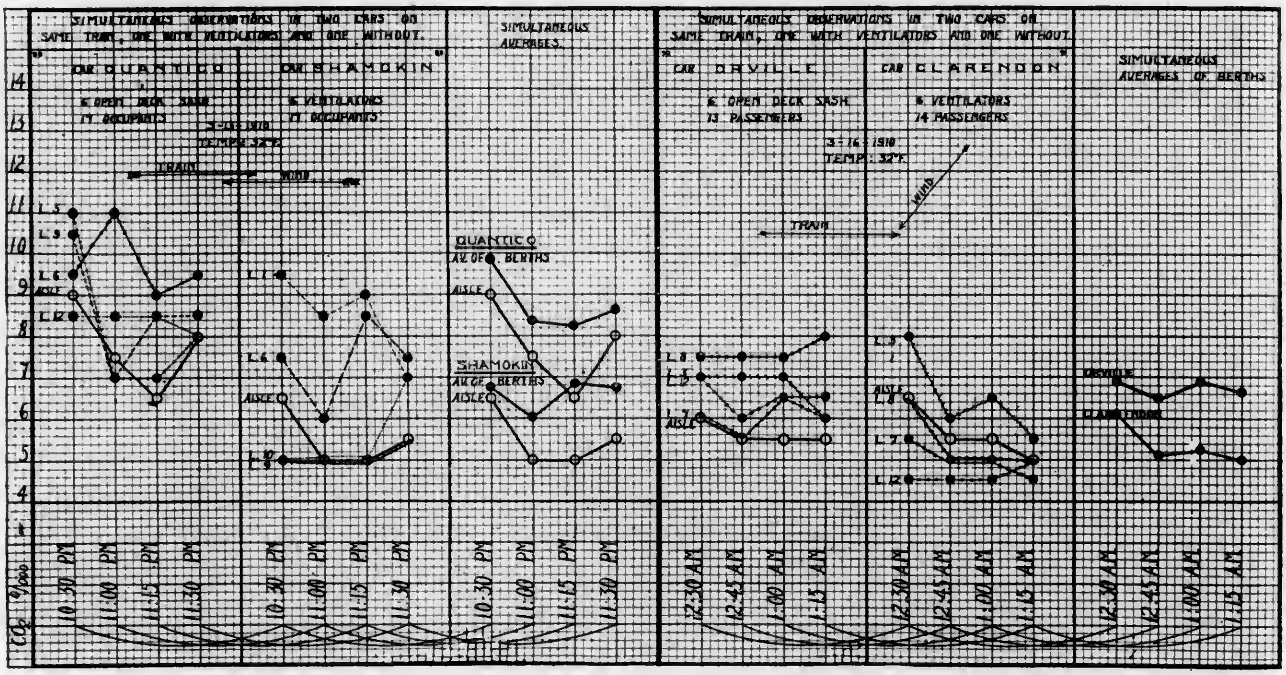


CHART I.

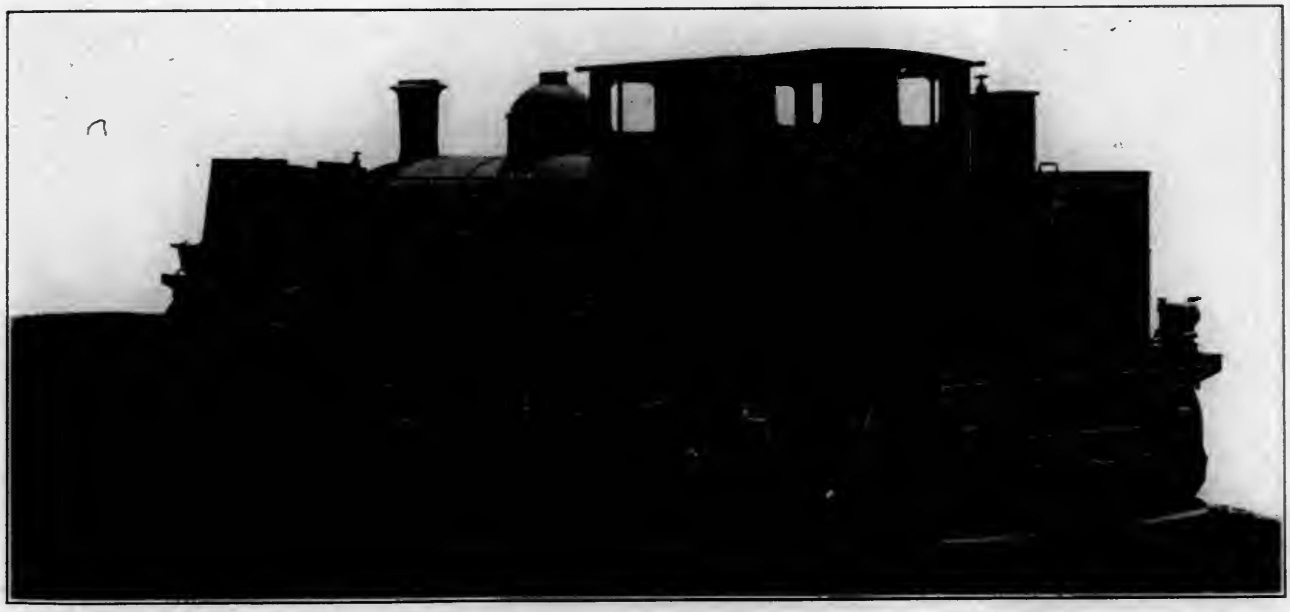
are brought out is by collecting samples from within a few inches of the tops or bottoms of the windows and from the body of the car. Thirty-three such comparisons were made. Twenty-three times the air taken from near the window crevices in this way showed no increase in carbon dioxid over the normal, while the interior had from 5 to 8 parts of carbon dioxid per 10,000. In these twenty-three instances it seems clear that fresh air was entering here at a sufficient rate to drive back all contaminated air for a distance of several inches. It is often possible to feel a draught on the hand placed near to such a crevice, especially if the outside air is cold. Now the least perceptible draught is about two miles per hour. If air is moving at this rate in the several inches lying inside a crevice it must be passing through the crevice itself at a much higher speed. Seven times the carbon dioxid by the windows was 4.5, when the car body showed 5 to 7. Twice it was 5, when the car body was 5.5 and 7. Once it was 6 when the car body was 8. In none of the thirty-three was it equal in contamination to the general air of the car.

Samples were taken from the inner ends of the passageways which lead to the end doors twenty-eight times. Seven times this air showed no contamination; the car body showed 5 to 8 parts carbon dioxid per 10,000. The other samples showed 4.5 to 8. Six times the air from the passage was higher than the average from the car. In one car four successive observations from the rear passageway showed no contamination, while the forward passageway always showed a contamination equal to or greater than the average for the body. It seems clear in this case that there was a continuous flow of air from the rear door inward—and probably an outward flow from the forward end of the car. Both doors were closed.

Even under the older applied principles of ventilation, the air-supply of sleeping-cars, as determined in this study, is ample under nearly all conditions. The average carbon dioxid in the air of running cars falls well within the limits of contamination permitted by the earlier investigators, and it is relatively rare that the individual observations show more than 10 parts in 10,000. In the light of the newer conceptions, which have as yet been applied in practice only to a very limited extent, this air-supply is ample under all conditions observed. No danger to health is to be apprehended under the conditions ordinarily obtaining even in still cars. They are occupied only for short periods as a rule and are not uncomfortable if kept cool. It would seem that the results obtained by the type of exhaust ventilator investigated in this study, which is now a part of the standard equipment of Pullman cars, are entirely adequate to meet the demands of hygiene, and that those difficulties and discomforts which do sometimes arise are due to other causes than lack of a sufficient amount of fresh air or to excessive vitiation. It is extremely unlikely that increasing the air-supply, which now amounts to from six to ten or more times the cubic content of the car each hour, and must maintain considerable motion of the atmosphere, would aid in any other way than by making overheating more difficult to bring about. Overheating is the paramount evil. It is the thing to be chiefly guarded against in the attempt to maintain comfort and good hygiene. It is not feasible to cool the naturally overheated air in summer, or to dry it when excessively humid. Fan motors and open windows are the available means by which the difficulties arising in hot weather may be most readily overcome. Carry away the body heat as rapidly as possible by a strong current of air. Though the avoidance of overheating in winter would seem to be an easy thing, its accurate control to meet the rapidly changing conditions under which cars may be operated is a matter of great difficulty. Experience has shown that it is necessary to have in sleeping-cars at least twice as much radiating surface as is demanded in common practice for heating the same space in houses; this in order to warm the large volume of air received and discharged so that it will maintain comfort to inactive passengers. To decrease this surface would be to fail to maintain a sufficiently high temperature on occasion. A system is needed capable of being quickly and effectively controlled to meet rapidly changing conditions. Such a system is now being experimented with in which there are multiple units of radiating surface, each with a separate control. The results so far indicate that from this a more uniformly comfortable condition can be maintained.

NOVEL NARROW GAUGE LOCOMOTIVE FOR AN INDIAN MOUNTAIN RAILWAY

One of the most interesting locomotives to be constructed in recent years has just been turned out of the shop of Boyer, Peacock and Company, Limited, Manchester, England, for service on the Darjeeling Himalayan Railway of India, where the conditions call forth requirements of a particularly exacting character, in fact without a parallel in the instance of smooth rail operation.



GARRATT LOCOMOTIVE DESIGNED FOR PARTICULARLY SEVERE CONDITIONS.

This is a narrow gauge line, 51 miles long, which was begun in 1879 and completed in 1881. Starting from Siliguri, 398 feet above the mean sea level, the line rises to a height of 7,407 feet at Ghoom Station, 47 miles away, and then descends to Darjeeling, four miles further, the terminus itself being 6,812 feet above sea level. The construction of this line, although only two feet gauge, presented, as may be imagined, serious difficulties, the steep ascent necessitating frequent loops or spirals and reverses, one of these latter having gradients of 1 in. 28 ft. The average ascent for the forty miles between Sookna and Ghoom is 170 feet per mile. For the first seven miles to Sookna Station the gradient is a gentle one, but from this point to the summit at Ghoom the average grades in the sections vary from 1 in 29 to 1 in 37, and there are many cases of curves of 70 ft. radius.

It was specified that the "Garratt" locomotive so-called, should

equal 6 times (17.7 per cent.). The relative ventilation is, of course, inversely as the carbon dioxid.

Six hundred and ninety carbon dioxid determinations of the air of lower berths and 53 of the air of upper berths in cars equipped with exhaust ventilators showed that in all but three of the forty-two cars (17, 31 and 37) the average carbon dioxid of the lower berths is higher than the average for the aisle. The average difference for all observations is 0.03 parts per 10,000 of air. The highest for the aisle is 10, the lowest 4.5; for the berths the highest is 13.5 and the lowest 4.5. In 20.4 per cent. of the berths the carbon dioxid is lower than the aisle at the same time; in 63.8 per cent. it is higher than the aisle, and in 15.8 per cent. they are equal.

The average carbon dioxid per berth is 6.66 per 10,000; the average ventilation is equivalent to 2,027 cubic feet per hour. The lowest average carbon dioxid for the berths of any car is 5.38, the highest is 9.34; the largest equivalent air-supply is 4,348 cubic feet per hour, and the smallest 1,123 cubic feet per hour. Of the 690 determinations of carbon dioxid only one, 0.14 per cent. is above 12 parts per 10,000; 3.3 per cent. are

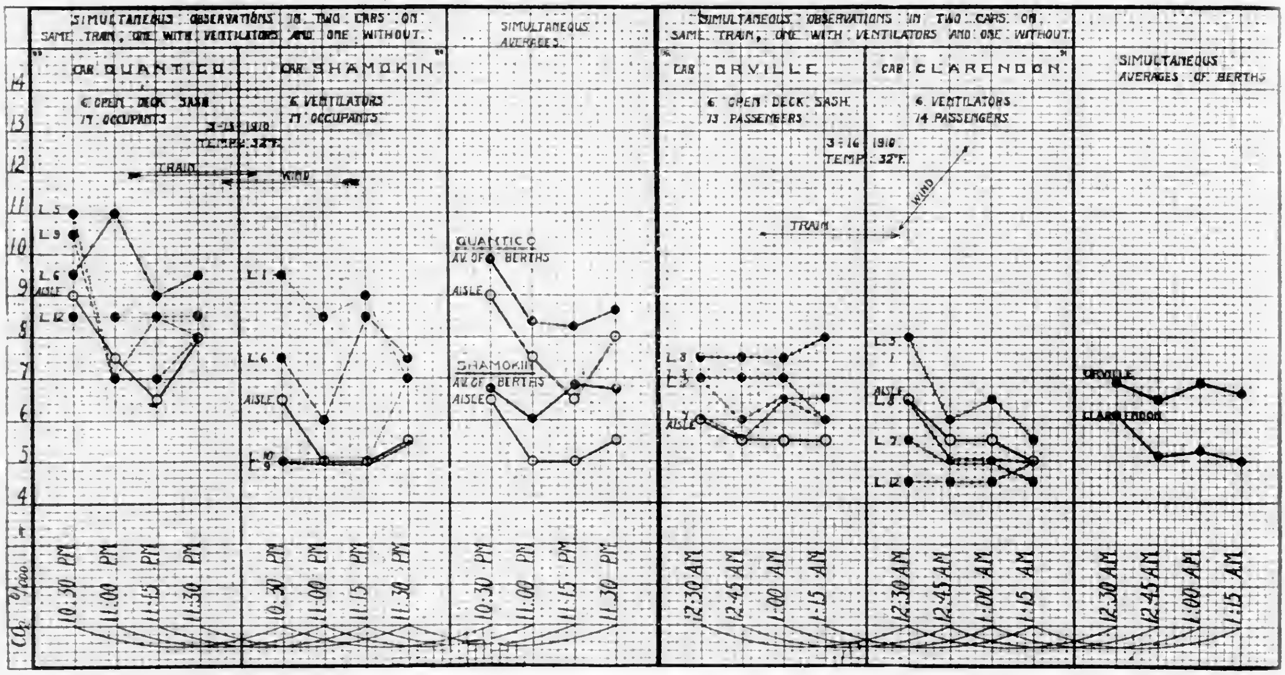


CHART I.

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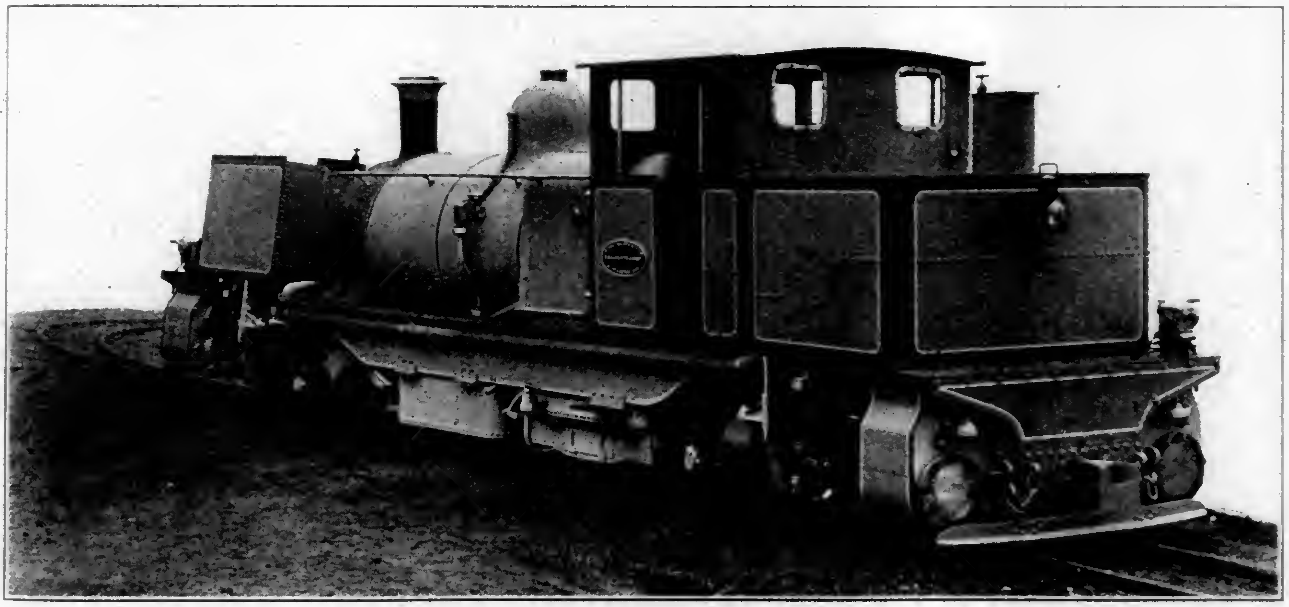
be brought out is by collecting samples from within a few inches of the tops or bottoms of the windows and from the body of the car. Thirty-three such comparisons were made. Twenty-three times the air taken from near the window crevices in this way showed no increase in carbon dioxid over the normal, while the interior had from 5 to 8 parts of carbon dioxid per 10,000. In these twenty-three instances it seems clear that fresh air was entering here at a sufficient rate to drive back all contaminated air for a distance of several inches. It is often possible to feel a draught on the hand placed near to such a crevice, especially if the outside air is cold. Now the least perceptible draught is about two miles per hour. If air is moving at this rate in the several inches lying inside a crevice it must be passing through the crevice itself at a much higher speed. Seven times the carbon dioxid by the windows was 4.5, when the car body showed 5 to 7. Twice it was 5, when the car body was 5.5 and 7. Once it was 6 when the car body was 8. In none of the thirty-three was it equal in contamination to the general air of the car.

Samples were taken from the inner ends of the passageways which lead to the end doors twenty-eight times. Seven times this air showed no contamination; the car body showed 5 to 8 parts carbon dioxid per 10,000. The other samples showed 4.5 to 8. Six times the air from the passage was higher than the average from the car. In one car four successive observations from the rear passageway showed no contamination, while the forward passageway always showed a contamination equal to or greater than the average for the body. It seems clear in this case that there was a continuous flow of air from the rear door inward—and probably an outward flow from the forward end of the car. Both doors were closed.

Even under the older applied principles of ventilation, the air supply of sleeping-cars, as determined in this study, is ample under nearly all conditions. The average carbon dioxid in the air of running cars falls well within the limits of contamination permitted by the earlier investigators, and it is relatively rare that the individual observations show more than 10 parts in 10,000. In the light of the newer conceptions, which have as yet been applied in practice only to a very limited extent, this air-supply is ample under all conditions observed. No danger to health is to be apprehended under the conditions ordinarily obtaining even in still cars. They are occupied only for short periods as a rule and are not uncomfortable if kept cool. It would seem that the results obtained by the type of exhaust ventilator investigated in this study, which is now a part of the standard equipment of Pullman cars, are entirely adequate to meet the demands of hygiene, and that those difficulties and discomforts which do sometimes arise are due to other causes than lack of a sufficient amount of fresh air or to excessive vitiation. It is extremely unlikely that increasing the air-supply, which now amounts to from six to ten or more times the cubic content of the car each hour, and must maintain considerable motion of the atmosphere, would aid in any other way than by making overheating more difficult to bring about. Overheating is the paramount evil. It is the thing to be chiefly guarded against in the attempt to maintain comfort and good hygiene. It is not feasible to cool the naturally overheated air in summer, or to dry it when excessively humid. Fan motors and open windows are the available means by which the difficulties arising in hot weather may be most readily overcome. Carry away the body heat as rapidly as possible by a strong current of air. Though the avoidance of overheating in winter would seem to be an easy thing, its accurate control to meet the rapidly changing conditions under which cars may be operated is a matter of great difficulty. Experience has shown that it is necessary to have in sleeping-cars at least twice as much radiating surface as is demanded in common practice for heating the same space in houses; this in order to warm the large volume of air received and discharged so that it will maintain comfort to inactive passengers. To decrease this surface would be to fail to maintain a sufficiently high temperature on occasion. A system is needed capable of being quickly and effectively controlled to meet rapidly changing conditions. Such a system is now being experimented with in which there are multiple units of radiating surface, each with a separate control. The results so far indicate that from this a more uniformly comfortable condition can be maintained.

NOVEL NARROW GAUGE LOCOMOTIVE FOR AN INDIAN MOUNTAIN RAILWAY

One of the most interesting locomotives to be constructed in recent years has just been turned out of the shop of Beyer, Peacock and Company, Limited, Manchester, England, for service on the Darjeeling Himalayan Railway of India, where the conditions call forth requirements of a particularly exacting character, in fact without a parallel in the instance of smooth rail operation.



GARRATT LOCOMOTIVE DESIGNED FOR PARTICULARLY SEVERE CONDITIONS

This is a narrow gauge line, 51 miles long, which was begun in 1879 and completed in 1881. Starting from Siliguri, 398 feet above the mean sea level, the line rises to a height of 7,407 feet at Ghoom Station, 47 miles away, and then descends to Darjeeling, four miles further, the terminus itself being 6,812 feet above sea level. The construction of this line, although only two feet gauge, presented, as may be imagined, serious difficulties, the steep ascent necessitating frequent loops or spirals and reverses, one of these latter having gradients of 1 in. 28 ft. The average ascent for the forty miles between Sookna and Ghoom is 170 feet per mile. For the first seven miles to Sookna Station the gradient is a gentle one, but from this point to the summit at Ghoom the average grades in the sections vary from 1 in 29 to 1 in 37, and there are many cases of curves of 70 ft. radius.

It was specified that the "Garratt" locomotive so-called, should

be able to negotiate reverse curves of 60 feet radius with a length to tangent between the curves of 20 feet only. Of this 20 feet tangent only 6 feet are level, as at 7 feet from each end the angle begins which raises the tangent to the super-elevation of 2½ inches on the outer rail of the curves. A trial line fulfilling these conditions was laid down in the ample extension grounds of the builder's works. The illustration of this new duplex locomotive, which briefly described may be said to consist of three main parts, viz., the boiler and frame and two motor bogies shows clearly the characteristic disposition of the component parts of the locomotive.

The general arrangement is that of the duplex truck, but beyond this it has little in common with other known types. Instead of the boiler being placed above the wheels as has hitherto been the practice, it is carried upon a girder frame which is pivoted and supported at its extreme ends on trucks, each of which may be likened to a locomotive without a boiler. These steam trucks with their water tanks and coal bunker together constitute the greater part of the weight of the locomotive and give stability to the running; furthermore, the center line of the boiler portion connecting the two trucks forms a chord of the curve on which the engine may be travelling, and the sharper the curve the greater will be the projection of the boiler weight towards the center of the curve.

Comparing the "Garratt" type with other forms of articulated locomotives, it will be seen that the most vital and novel element is contained in the fact that the boiler lies completely between the two main connecting points of the boiler frame, without the boiler frame materially overhanging the connecting points. In all other articulated types the frame is superimposed upon the trucks and extends over the whole or nearly the whole length of the machine. The first consequence of the Garratt form of construction is that the size of the boiler and size of wheels and tank accommodation need never be considered in relation to one another, merely by reason of the limitations hitherto imposed, for as there are no wheels under the boiler in this type of locomotive, and no side tanks on the carrying frames, the boiler is unrestricted as regards the position of its center line or as regards its diameter. It is therefore possible with this type to get the maximum boiler requirements with a relatively short boiler. The size of the boiler does not affect the size of the wheels, as the boiler is suspended between the trucks carrying the wheels and bunkers.

A second consequence of the arrangement is that there is no part of the boiler-carrying frame materially overhanging the truck centers, and that both of the trucks are constructed as tank trucks carrying fuel and water supply tanks as integral portions of themselves. It will be seen, therefore, that a type of locomotive is hereby created possessing perfect pliability and stability combined with entire freedom from the usual restrictions which have hitherto governed the construction of the articulated locomotive. The trucks are designed so that the weight is well distributed and alterations of the amount of fuel and water carried affect the distribution to only a slight extent. The weight of fuel and water bears but a small proportion to the weight of the trucks and to the load they have to bear, and the chief point to be cared for is the correct placing of the truck center with regard to the center of gravity of the truck. In the case of the engine illustrated the figures given for the weight on the truck will show how well the total engine weight is distributed.

Turning to some details of the locomotive illustrated, which is the first to be built for this particular railway, it will be observed that in the arrangement embodied the whole of the adhesion weight is carried by the coupled wheels. The cylinders are four in number and are 11 inches in diameter by 14 inches stroke. They are placed outside the frames with their slide valves above, and are worked by the Walschaert valve gear. The frames are placed outside the wheels, and the journal boxes and springs outside the frames. Outside cranks are provided with counterbalance extensions. The water tanks, which have a total capacity of 850 gallons, are three in number, one being placed on the truck at the smokebox end, one underneath the boiler barrel, and the third combined with the fuel bunker is fixed on the truck at the firebox end. All these tanks are connected by means of suitable piping, and are filled through the fillholes seen in the photograph at either end of the engine.

An interesting feature is the design of the truck centers. There is a flat surface at the firebox and as well two side bearing surfaces. At the smokebox end the swivelling surface is dished, and there are no side bearing surfaces. The effect is, therefore, to give to the boiler-carrying frame a three point suspension, which gives the whole machine a remarkable capacity for adjusting itself to the several curves and super-elevation of the rails.

The boiler barrel is 3 ft. 10⅞ in. outside, and 7 ft. long, and the firebox shell, which is of the Belpaire form, is 4 ft. 8 ins. long and 4 ft. 9½ ins. wide, with internal firebox of copper. It will be observed that the provision of a boiler of large capacity with wide and deep firebox has presented no difficulty even with so small a gauge as 2 ft. The boiler is placed in a plate framing, and is fixed at the smokebox end; allowance for expansion is, as usual, provided at the firebox end. Drummond duplex safety valves loaded to 160 lbs. pressure are carried on the dome, and two of Gresham & Craven's No. 8 injectors are provided. The frame is built up of plates, angles, etc., the main longitudinals being ¾ inches in thickness. The throttle valves are provided in the dome, with independent rods and levers arranged to work together or disconnect one from the other. One goes to the smokebox in the ordinary way, and one to the rear is brought out through the back of the firebox and underneath the footplate to the truck center. Connection with the steam pipes to the cylinders is made through ball joints on the center line of the truck pivot into a pair leading to the exhaust pipe in the stack, to which the exhaust from the front truck cylinders is also connected by means of a sliding pipe with universal joint This is plainly seen in the sectional view. The axles and tires were supplied by Messrs. Vickers, Son & Maxim, Ltd. The couplings are of the standard Darjeeling Himalayan type, and fenders are provided as rail guards. Both trucks are provided with the vacuum brakes, and there is also a hand screw brake to the rear truck. The principal dimensions are as follows:

Cylinders, outside	4
Cylinders, diameter and stroke	11 in. by 14 in.
Boiler length	7 ft.
Boiler diameter outside (at front)	46⅞ in.
Tubes, No. and diameter	195—1⅝ in.
Heating surface, tubes	603 sq. ft.
Heating surface, firebox	64 sq. ft.
Heating surface, total	667 sq. ft.
Grate area	17.5 sq. ft.
Boiler pressure	160 lbs.
Tractive force per lb. of mean effective pressure in cylinder	130.2
Wheelbase—centre to centre of trucks	17 ft. 3 in.
Truck wheelbase	4 ft. 3 in.
Total wheelbase	24 ft. 6 in.
Weight on front truck	30,820 lbs.
Weight on rear truck	31,660 lbs.
Weight, total	62,480 lbs.
Tank—Water capacity	850 gallons
Fuel space	1 ton of coal

Enormous Growth of Railroad Earnings.—On July 1, 1901, there were in the United States reporting to the commission, 195,561 miles of railway, yielding a gross operating revenue of $1,572,960,868, or $8,043 per mile. The net operating revenue amounted to $577,221,171, or $2,951 per mile. On July 1, 1910, there were 238,411 miles of line, with $2,818,411,419 gross income, or $11,822 per mile. The net operating revenue reached the unparalleled figure of $932,848,978, or 3,913 per operated mile, an increase of 50 per cent. in net per mile over the figures of ten years ago.

Steel Production in 1910.—The production of all kinds of steel ingots and castings in the United States in 1910, according to the American Iron and Steel Association, amounted to 26,094,919 tons, against 23,955,021 tons in 1909, an increase of 2,139,898 tons, or almost 9 per cent. The output in 1910 was the largest in the country's history. The year of the next largest outturn was 1909.

ALUMINUM PULLEYS ON PLANERS

Anyone acquainted with planers is familiar with the fly-wheel action of the tight pulley. Especially on a planer with a high countershaft speed, this is a very serious and costly feature, and much valuable time is lost by the over run of the table at each end of the stroke, to overcome which the belts must be tightened up to such an extent that they very soon wear out the loose pulleys. Another serious feature is the rapid deterioration of the belts. The friction and its resultant heat, caused by the belt overcoming the momentum of the tight pulleys at the instant of reverse, causes rapid wearing of the belts and very soon destroys them.

Experience has shown that the substitution of an aluminum pulley for the cast iron in the case of a 36-in. planer where the two pulleys weigh 35 and 105 lbs. respectively, completely overcomes these conditions. By applying the formula for momentum it is found that the aluminum alloy pulley of the same dimensions, and running at the same velocity as the cast iron pulley, will, by virtue of its lower specific gravity, develop less momentum, in the same proportion as the difference between the specific gravities of the two metals. Therefore, the aluminum under the same running conditions will develop only about one-third of the momentum that a cast iron pulley will. The advantages of this are readily apparent. The belts do not have such a tremendous force to overcome, and will, therefore, "pick up" more quickly, thus effectually eliminating practically all over-run of the table.

At first thought it may seem that the over-run of the table is more largely due to the momentum of the table itself than to that of the driving pulley; however, the contrary is the truth. By using the formula for calculating the momentum of the table and of the cast iron driving pulley on an "American" 36 in. x 10 ft. planer, it will be found that the momentum of the pulley is over 56 times that of the table. In other words, if the momentum of the table were sufficient to cause an over-run of one inch, the momentum of the driving pulley would cause an over-run of approximately 56 inches. Calculating the momentum of the table and aluminum pulley by the same formula as used above, it will be found that the momentum of the pulley is only 15 times that of the table.

Recognizing the importance of these features, the American Tool Works Company of Cincinnati carried out a long series of practical tests in its own shop which fully proved the practical advantage to be derived and this company now announces that all of its larger-sized planers, 36-in. heavy pattern and up, will be fitted with aluminum alloy pulleys. This new pulley is very similar in construction to the regular cast iron pulley formerly furnished, the only decided difference being the design of the arms, which are made "S" shape, thus permitting sufficient elasticity to prevent any possible breakage, due to the arms shrinking away from the rim.

M. M. & M. C. B. COMMITTEES

It has been announced by the secretary that the selection of committees for the ensuing year is as follows:

M. M. STANDING COMMITTEES.

Advisory Technical: G. W. Wildin, A. W. Gibbs, W. A. Nettleton.

Revision of Standards: T. W. Demarest, J. D. Harris, W. E. Dunham.

Mechanical Stokers: T. Rumney, E. D. Nelson, C. E. Gossett, J. A. Carney, T. O. Sechrist, S. K. Dickerson, George Hodgins.

M. M. SPECIAL COMMITTEES.

Specifications for Cast-steel Locomotive Frames: E. D. Bronner, E. W. Pratt, R. K. Reading, O. C. Cromwell, C. B. Young, C. E. Fuller, L. R. Pomeroy.

Main and Side Rods: W. F. Kiesel, H. Bartlett, G. Lanza, H. B. Hunt, W. E. Dunham.

Consolidation: D. F. Crawford, H. H. Vaughan, G. W. Wildin.

Safety Valves: F. M. Gilbert, James Milliken, W. D. Robb, Prof. E. C. Schmidt, W. J. Tollerton.

Safety Appliances: H. T. Bentley, M. K. Barnum, C. B. Young.

Design, Construction and Maintenance of Locomotive Boilers: D. R. MacBain, C. E. Chambers, T. W. Demarest, F. H. Clark, R. E. Smith, E. W. Pratt, J. Snowden Bell.

Contour of Tires: W. C. A. Henry, J. A. Pilcher, O. C. Cromwell, H. C. Oviatt, O. M. Foster, G. W. Seidel.

Steel Tires: L. R. Johnson, J. R. Onderdonk, C. H. Hogan, R. L. Ettenger, L. H. Turner.

Flange Lubrication: M. H. Haig, T. W. Heintzleman, D. J. Redding, A. Kearney, W. C. Hayes.

Minimum Requirements for Headlights: D. F. Crawford, A. R. Ayers, C. H. Rae, F. H. Scheffer, J. W. Small, F. A. Torrey.

Standardization of Tinware: A. J. Poole, M. D. Franey, J. C. Mengel.

Maintenance of Superheater Locomotives: R. D. Smith, W. H. Bradley, H. H. Vaughan, Jas. Chidley, J. B. Kilpatrick.

Arrangements: H. T. Bentley.

M. C. B. STANDING COMMITTEES.

Arbitration: J. J. Hennessey, T. W. Demarest, J. S. Lentz, W. A. Nettleton, E. D. Bronner.

Revision of Standards and Recommended Practice: R. L. Kleine, W. E. Dunham, T. H. Goodnow, W. H. V. Rosing, C. E. Fuller, T. M. Ramsdell, O. C. Cromwell.

Train Brake and Signal Equipment: R. B. Kendig, T. L. Burton, B. P. Flory, E. W. Pratt, B. K. Reading.

Brake Shoe Equipment: Prof. C. H. Benjamin, C. D. Young, R. B. Kendig.

Coupler and Draft Equipment: R. N. Durborow, G. W. Wildin, F. W. Brazier, J. F. DeVoy, F. H. Stark, H. La Rue, H. L. Trimyer.

Rules for Loading Materials: A. Kearney, R. E. Smith, C. H. Osborn, L. H. Turner, W. F. Kiesel, Jr.

Car Wheels: William Garstang, W. C. A. Henry, A. E. Manchester, R. W. Burnett, R. L. Ettenger, J. A. Pilcher, O. C. Cromwell.

Safety Appliances: A. Stewart, A. La Mar, C. B. Young, H. Bartlett, T. M. Ramsdell, M. K. Barnum, W. O. Thompson.

M. C. B. SPECIAL COMMITTEES.

Car Trucks: A. S. Vogt, C. A. Seley, J. J. Tatum, F. P. Pfahler, R. W. Burnett, N. L. Friese, G. A. Hancock.

Prices for Labor and Material: F. H. Clark, G. E. Carson, C. F. Thiele, Ira Everett, B. Julien, S. T. Park, H. E. Passmore.

Springs for Freight Car Trucks: F. M. Gilbert, W. F. Kiesel, Jr., W. E. Sharp, T. A. Lawes, J. R. Onderdonk.

Consolidation: F. H. Clark, W. A. Nettleton, C. A. Schroyer.

Train Lighting and Equipment: T. R. Cook, C. A. Brandt, Ward Barnum, J. H. Davis, E. A. Benson, D. J. Cartwright, E. W. Jansen.

Train Pipe and Connections for Steam Heat: I. S. Downing, C. A. Schroyer, W. C. Arp, T. H. Russum, J. J. Ewing.

Nominations: J. F. Deems, A. W. Gibbs, C. A. Seley, W. H. Lewis, J. F. Walsh.

Arrangements: A. Stewart.

Tank Cars: A. W. Gibbs, C. M. Bloxham, J. W. Fogg, S. K. Dickerson, C. E. Chambers, E. J. Searles, T. Rumney.

Specifications for Tests of Steel Truck Sides and Bolsters for Cars of 80,000, 100,000, 150,000 Pounds Capacity: Prof. E. C. Schmidt, J. S. Sheafe, C. D. Young.

Capacity Marking of Cars: C. E. Fuller, J. F. Deems, M. K. Barnum, A. W. Gibbs, F. H. Clark.

Revision of Constitution: D. F. Crawford, C. A. Seley, A. Kearney.

Lettering Cars: D. F. Crawford, J. F. Deems, F. H. Clark, W. A. Nettleton, F. A. Torrey.

Individual Paper, Car Shop Apprentices: I. S. Downing.

POWERFUL CYLINDER BORING MACHINE

In the accompanying illustration is shown a newly designed cylinder boring machine which has a capacity for boring up to 40 inches in diameter and boring and facing cylinders up to 50 inches in length. This machine is very powerful and is constructed in every particular to maintain its rigidity and accuracy under the most severe working conditions. A consideration of some of the details of construction clearly indicates this feature as well as the efficiency and convenience of operation.

The spindle is 8 in. in diameter and is driven by a sleeve which revolves in a bearing at each end of the head, having a length over all of 33 in. On the center of the spindle sleeve between the two end bearings, is mounted the driving worm wheel, which has a cast iron center in a bronze ring, into which are cut 6-in. pitch triple lead teeth; the driving worm is of hardened steel with roller thrust bearings. The outer end of the spindle is arranged to drive a spindle sleeve having a bearing of large diameter, about 20 in. in length in the outboard head. The feed motion to the bar is transmitted by means of a trolley yoke with which any number of grips on the bar may be taken, motion being transmitted to the trolley by means of two pinions meshing in racks on each bearing of the horn, as shown in the illustration. The facing arms are mounted on extensions of the spindle sleeves, permitting the adjustment of the spindle without removing the facing arms.

NEWTON CYLINDER BORING MACHINE.

As shown, this machine is furnished when desired, with a counterbalance to equalize the weight of the facing arms and insure a steady even motion of the spindle when boring and facing at the same time. Where desired, the facing arm can remain stationary while the spindle rotates; the facing arms are furnished with swiveling tool holders, mounted on a slide having reversing power feed.

The particular machine illustrated is intended to be variable speed motor driven from the single pulley shown, on which is mounted spur gears transmitting the motion to the driving worm. The motion for the feed is taken from the end of the driving worm shaft to an idle male friction gear for the fast traverse, and to a worm wheel for the feed; the worm wheel is mounted on the feed box shaft which through the different combinations gives nine changes of gear feed. A hand lever operates the friction clutch controlling the fast traverse of the spindle, also the tooth clutch engaging the feed. With this design of drive and feed, it is possible to obtain a great variation in the spindle speed, although the present machine is arranged for three to nine r. p. m. of the spindle, and feeds from .062 in. to .647 in. per revolution of the spindle.

The length of the feed is 72 in., distance from center of spindle to top of work table is 37½ in., the working surface being 34 in. wide by 71 in. long.

This machine is built by the Newton Machine Tool Works, Philadelphia, Pa.

ASSIST THE MANUFACTURERS

To encourage the maintenance of standards, and uniformity of design, it is sometimes good business policy to purchase finished products from the manufacturer at a cost slightly higher than some of the detail parts could be manufactured by the railway.

I have in mind at this time the air brake equipment, with its various designs, its multiplicity of parts, each design classified, each part symbolized.

The organization of this industry is so perfect as to standardize the air brake equipment on the railways of the world, any part great or small is symbolized in its class, and will interchange with any of the hundreds of parts for which it is symbolized, wherever they may be found.

Improved designs have been developed as required to meet new conditions, an efficient corps of experts are employed to design, build and improve these features, they check the service, note defects and assist in developing perfection.

This organization increases the overhead charges, though it insures a more perfect air brake equipment; its cost of maintenance must be spread over the product of the plant and be paid for by the consumer.

The above applies to many other manufacturers who devote their time and energy to the design and development of railway specialties. I am mindful of the assistance rendered by the railway organization in suggesting and assisting to perfect these designs when I say such industries should be encouraged as far as consistent with sound business methods.—*M. D. Francy at the Railway Storekeepers' Convention.*

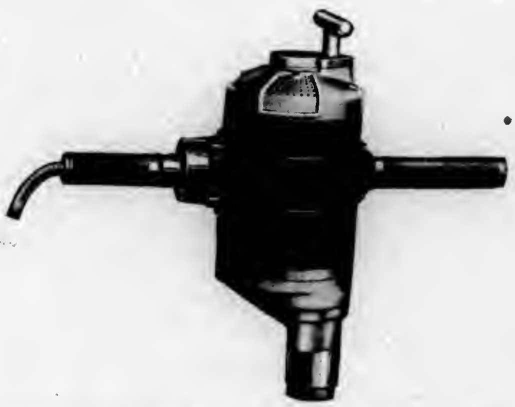
The Presence of Bismuth in Brass is one of the causes of its fire cracking when annealed, but more is required to produce the cracking than is ever found in the copper from which commercial brass is made. While a possible cause of fire cracking, it is one of the least frequent.

PORTABLE ELECTRIC DRILLS & REAMERS

In many railroad shops power for portable drills and reamers is cheaper in the shape of electric current than it is with compressed air, and when the greater convenience, less weight and general advantage of a smaller motor found in the latest electric portable machines is considered it is not surprising that so much interest was aroused at the last Atlantic City convention by the exhibit of the Van Dorn and Dutton Co. of Cleveland, Ohio.

This company had on exhibition and in operation eight different types of machines, six for direct current and two for alternating current ranging in capacity for drilling in steel from ⅛ to 2 inches diameter. While the portable electric machines are a comparatively new thing, this demonstration showed that most satisfactory progress has been made in their development and that all reasonable requirements can now be fulfilled.

In the construction of the Van Dorn & Dutton machines straight series motors, developing the greatest factor of power obtainable for size and weight, are being used. The armature is of the slotted drum type, built up of soft, steel laminations,



PORTABLE ELECTRICAL DRILL OF EXCEPTIONAL POWER.

on a hollow shaft, these laminations being made from steel of a special analysis to give the highest efficiency. Each lamination is carefully and uniformly insulated. In the larger machines the field frames are constructed of steel of a special analysis, by means of which the best results are obtained. In the smaller machines, the field frames are built up of laminations much in a manner similar to the armature.

Exhaustive consideration has been given to the matter of lubrication and bearings, experience having proven that these two features are of the greatest importance in the construction of tools of this character. The gears are enclosed in a gear case, entirely separate from the windings, this gear case serving as a lubricant chamber, as well as a housing for the gears. By means of canals lubricant reaches all bearings, with the exception of that supporting the spindle, which is lubricated by a receptacle easily accessible. In revolving, the gears force the lubricant through these canals, insuring a proper and sufficient supply at all times. The oiling system is so devised that one charge of non-fluid oil in the gear case will answer for several weeks. Ordinary machine oil can be used for lubricating the spindle.

The wipe system employed at the spindle is so arranged that the wick is constantly in contact with the spindle, extending into the oil chamber. The bearings are proportioned with an excess factor of safety. The system used was adopted after exhaustive consideration of the subject on the part of experts in this branch of engineering and has withstood the severest tests.

In the larger machines for reaming, mechanically operated automatic switches are used, which will automatically stop the machine should the operator accidentally release the handles when the tool is in operation. These switches will at all times break the current instantaneously, thus eliminating a heavy and destructive arcing. In the smaller machines switches of a special design are also employed, the design used being strong mechanically. The switch contacts are so designed that when wear is shown, they are easily replaced at a very small cost.

The general construction of this line of machines is such that the tools are easily assembled and disassembled, all parts being interchangeable and easily accessible.

In the larger machines four-pole construction is employed, whereas the small tools are of the two-pole construction. The design is such that the harder the tool is forced, the greater the torque or working power.

COLUMBIA HIGH SPEED UNIVERSAL CHUCK

If the full advantage of high speed tool steels are to be obtained it is as necessary that the chuck used should be adapted and suited to its work as it is that the machine tool should be more powerful and rigid. Recognizing that the ordinary

NEW TYPE OF CHUCK.

chuck was proving the weak link in the chain, Schuchardt and Schutte, 90 West street, New York, have put on the market a new type of chuck which is designed throughout for use with the heaviest cuts and to maintain its accuracy and grip indefinitely under the most severe service.

This chuck is constructed along entirely new lines, as is shown in the illustration. The spiral thread for moving the jaws in and out is "V"-shaped and is cut on the sloping inside surface of a steel ring, which is hardened and subsequently ground to obtain the greatest accuracy in regard to true running. The pitch of the thread, as is shown in the drawing, is considerably finer than that of the ordinary scroll chuck, thereby increasing

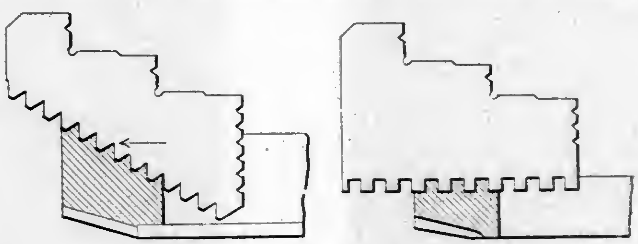


ILLUSTRATION OF ADVANTAGE OF THE "V" THREAD.

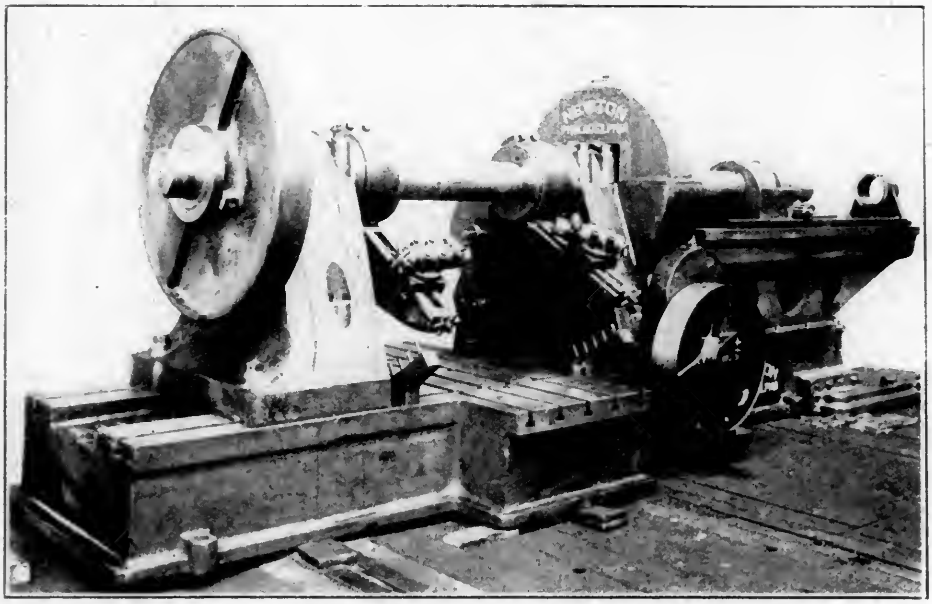
the gripping power and area of wearing surface. This chuck, however, is not adapted for holding rings, etc., on the inside. The sloping surface of the body gives greater support to the jaws and insures the greatest possible rigidity. The jaws are almost covered by the chuck body and do not protrude, reducing the possibility of accidents to the operator, by being caught by the hands or clothing. Owing to the ground surface on the spiral steel ring, the friction on the ways is reduced to a minimum.

IRON PIPES LINED WITH LEAD are made for the transmission of acids which would quickly destroy unprotected iron. These pipes are made up to large sizes. One copper smelting company, for instance, has 30,000 ft. of 10 in. pipe lined with lead which has been in use twelve years.

POWERFUL CYLINDER BORING MACHINE

In the accompanying illustration is shown a newly designed cylinder boring machine which has a capacity for boring up to 40 inches in diameter and boring and facing cylinders up to 50 inches in length. This machine is very powerful and is constructed in every particular to maintain its rigidity and accuracy under the most severe working conditions. A consideration of some of the details of construction clearly indicates this feature as well as the efficiency and convenience of operation.

The spindle is 8 in. in diameter and is driven by a sleeve which revolves in a bearing at each end of the head, having a length over all of 33 in. On the center of the spindle sleeve between the two end bearings, is mounted the driving worm wheel, which has a cast iron center in a bronze ring, into which are cut 6-in. pitch triple lead teeth; the driving worm is of



NEWTON CYLINDER BORING MACHINE

hardened steel with roller thrust bearings. The outer end of the spindle is arranged to drive a spindle sleeve having a bearing of large diameter, about 20 in. in length in the outboard head. The feed motion to the bar is transmitted by means of a trolley yoke with which any number of grips on the bar may be taken, motion being transmitted to the trolley by means of two pinions meshing in racks on each bearing of the horn, as shown in the illustration. The facing arms are mounted on extensions of the spindle sleeves, permitting the adjustment of the spindle without removing the facing arms.

As shown, this machine is furnished when desired, with a counterbalance to equalize the weight of the facing arms and insure a steady even motion of the spindle when boring and facing at the same time. Where desired, the facing arm can remain stationary while the spindle rotates; the facing arms are furnished with swiveling tool holders, mounted on a slide having reversing power feed.

The particular machine illustrated is intended to be variable speed motor driven from the single pulley shown, on which is mounted spur gears transmitting the motion to the driving worm. The motion for the feed is taken from the end of the driving worm shaft to an idle male friction gear for the fast traverse, and to a worm wheel for the feed; the worm wheel is mounted on the feed box shaft which through the different combinations gives nine changes of gear feed. A hand lever operates the friction clutch controlling the fast traverse of the spindle, also the tooth clutch engaging the feed. With this design of drive and feed, it is possible to obtain a great variation in the spindle speed, although the present machine is arranged for three to nine r. p. m. of the spindle, and feeds from .062 in. to .647 in. per revolution of the spindle.

The length of the feed is 72 in., distance from center of s[illegible]dle to top of work table is 37½ in., the working surface b[illegible] 34 in. wide by 71 in. long.

This machine is built by the Newton Machine Tool W[illegible], Philadelphia, Pa.

ASSIST THE MANUFACTURERS

To encourage the maintenance of standards, and unifor[illegible] of design, it is sometimes good business policy to purchas[illegible] ished products from the manufacturer at a cost slightly hi[illegible] than some of the detail parts could be manufactured by [illegible] railway.

I have in mind at this time the air brake equipment, w[illegible] various designs, its multiplicity of parts, each design class[illegible] each part symbolized.

The organization of this industry is so perfect as to s[illegible] ardize the air brake equipment on the railways of the w[illegible] any part great or small is symbolized in its class, and wil[illegible] terchange with any of the hundreds of parts for which [illegible] symbolized, wherever they may be found.

Improved designs have been developed as required to [illegible] new conditions, an efficient corps of experts are employe[illegible] design, build and improve these features, they check the ser[illegible] note defects and assist in developing perfection.

This organization increases the overhead charges, thoug[illegible] insures a more perfect air brake equipment; its cost of m[illegible] tenance must be spread over the product of the plant an[illegible] paid for by the consumer.

The above applies to many other manufacturers who de[illegible] their time and energy to the design and development of r[illegible] way specialties. I am mindful of the assistance rendere[illegible] the railway organization in suggesting and assisting to per[illegible] these designs when I say such industries should be encoura[illegible] as far as consistent with sound business methods.—*M[illegible] Francy at the Railway Storekeepers' Convention.*

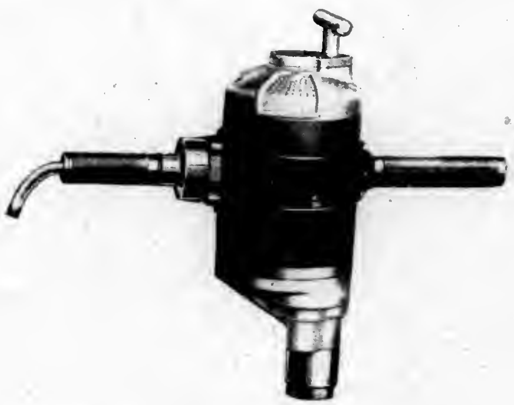
The Presence of Bismuth in Brass is one of the causes [illegible] its fire cracking when annealed, but more is required to p[illegible] duce the cracking than is ever found in the copper from wh[illegible] commercial brass is made. While a possible cause of fire cra[illegible] ing, it is one of the least frequent.

PORTABLE ELECTRIC DRILLS & REAMERS

In many railroad shops power for portable drills and reamers cheaper in the shape of electric current than it is with compressed air, and when the greater convenience, less weight and general advantage of a smaller motor found in the latest electric portable machines is considered it is not surprising that so much interest was aroused at the last Atlantic City convention by the exhibit of the Van Dorn and Dutton Co. of Cleveland, Ohio.

This company had on exhibition and in operation eight different types of machines, six for direct current and two for alternating current ranging in capacity for drilling in steel from ¼ to 2 inches diameter. While the portable electric machines are a comparatively new thing, this demonstration showed that most satisfactory progress has been made in their development and that all reasonable requirements can now be fulfilled.

In the construction of the Van Dorn & Dutton machines straight series motors, developing the greatest factor of power obtainable for size and weight, are being used. The armature is of the slotted drum type, built up of soft, steel laminations,



PORTABLE ELECTRICAL DRILL OF EXCEPTIONAL POWER.

on a hollow shaft, these laminations being made from steel of special analysis to give the highest efficiency. Each lamination is carefully and uniformly insulated. In the larger machines the field frames are constructed of steel of a special analysis, by means of which the best results are obtained. In the smaller machines, the field frames are built up of laminations much in a manner similar to the armature.

Exhaustive consideration has been given to the matter of lubrication and bearings, experience having proven that these two features are of the greatest importance in the construction of tools of this character. The gears are enclosed in a gear case, entirely separate from the windings, this gear case serving as a lubricant chamber, as well as a housing for the gears. By means of canals lubricant reaches all bearings, with the exception of that supporting the spindle, which is lubricated by a receptacle easily accessible. In revolving, the gears force the lubricant through these canals, insuring a proper and sufficient supply at all times. The oiling system is so devised that one charge of non-fluid oil in the gear case will answer for several weeks. Ordinary machine oil can be used for lubricating the spindle.

The wipe system employed at the spindle is so arranged that the wick is constantly in contact with the spindle, extending to the oil chamber. The bearings are proportioned with an excess factor of safety. The system used was adopted after exhaustive consideration of the subject on the part of experts in this branch of engineering and has withstood the severest tests.

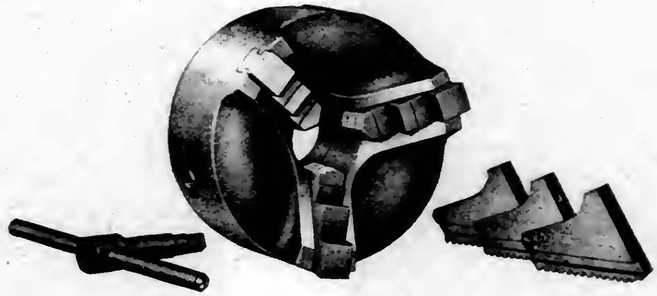
In the larger machines for reaming, mechanically operated automatic switches are used, which will automatically stop the machine should the operator accidentally release the handles when the tool is in operation. These switches will at all times break the current instantaneously, thus eliminating a heavy and destructive arcing. In the smaller machines switches of a special design are also employed, the design used being strong mechanically. The switch contacts are so designed that when wear is shown, they are easily replaced at a very small cost.

The general construction of this line of machines is such that the tools are easily assembled and disassembled, all parts being interchangeable and easily accessible.

In the larger machines four-pole construction is employed, whereas the small tools are of the two-pole construction. The design is such that the harder the tool is forced, the greater the torque or working power.

COLUMBIA HIGH SPEED UNIVERSAL CHUCK

If the full advantage of high speed tool steels are to be obtained it is as necessary that the chuck used should be adapted and suited to its work as it is that the machine tool should be more powerful and rigid. Recognizing that the ordinary



NEW TYPE OF CHUCK.

chuck was proving the weak link in the chain, Schuchardt & Schutte, 90 West street, New York, have put on the market a new type of chuck which is designed throughout for use with the heaviest cuts and to maintain its accuracy and grip indefinitely under the most severe service.

This chuck is constructed along entirely new lines, as is shown in the illustration. The spiral thread for moving the jaws in and out is "V"-shaped and is cut on the sloping outside surface of a steel ring, which is hardened and subsequently ground to obtain the greatest accuracy in regard to true running. The pitch of the thread, as is shown in the drawing, is considerably finer than that of the ordinary scroll chuck, thereby increasing

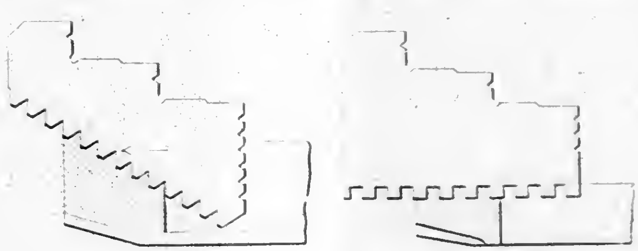


ILLUSTRATION OF ADVANTAGE OF THE "V" THREAD.

the gripping power and area of wearing surface. This chuck, however, is not adapted for holding rings, etc., on the inside. The sloping surface of the body gives greater support to the jaws and insures the greatest possible rigidity. The jaws are almost covered by the chuck body and do not protrude, reducing the possibility of accidents to the operator, by being caught by the hands or clothing. Owing to the ground surface on the spiral steel ring, the friction on the ways is reduced to a minimum.

IRON PIPES LINED WITH LEAD are made for the transmission of acids which would quickly destroy unprotected iron. These pipes are made up to large sizes. One copper smelting company, for instance, has 30,000 ft. of 10 in. pipe lined with lead which has been in use twelve years.

AUTOMATIC WATER WEIGHER

In many cases it is of great advantage to have an accurate knowledge of the amount of water being used in boilers, for cooling, for washout systems, etc., especially where it can be determined for any desired interval of time with reliable accuracy. Such knowledge has often resulted in the discovery of unthought-of sources of waste and permits the constant maintenance of a high state of efficiency in certain features with its reflected effect on many others.

An apparatus remarkable for its simplicity, which is guaranteed to record the correct weight of the water used within one-half of one per cent., has recently been perfected by The Kennicott Co., Chicago Heights, Ill., and is shown in the accompanying illustration.

It consists of a shell, the lower part of which is divided by a partition into two measuring or weighing compartments, a siphon being provided in each compartment for discharging the water when the full unit charge has been received. A tipping box composed of two halves, which alternately fill with water, serves the double purpose of furnishing a sufficient quantity of water to start the siphons and to shift the supply from one compartment to the other. This tipping box is balanced on pivots, being mounted directly above the weighing compartment and is operated by floats, one in either compartment.

The operation of the weigher is as follows: Water enters the inlet and passes to the tipping box, where a small portion of it is intercepted, the remainder passing directly to the weighing compartment below. When this compartment is nearly filled, the float tips the tipping box, thereby automatically spilling the water contained in the tipping box into the compartment, thus completing the unit charge and starting the siphon which discharges the unit charge, while the entering water passes to the opposite half of the tipping box and into the opposite compartment, which fills and empties in a like manner. A counter registers each double unit charge delivered by the weigher, and is so arranged that it cannot be tampered with by unauthorized persons.

The complete equipment with the Kennicott Water Weigher includes a storage tank and balanced pressure inlet valve. The balanced pressure inlet valve is controlled by a ball float in the storage tank below the weigher, which automatically regulates the supply to meet the varying demands of the plant and insures that the storage tank is always full of water.

KENNICOTT WATER WEIGHER.

Especial attention is given to the careful test and calibration which each weigher receives before being shipped. The unit charges are accurately weighed on scales and a certificate of accuracy and capacity accompanies each shipment. The weigher is guaranteed to record the correct weight of water to within one-half of one per cent. of absolute accuracy and repeated tests, made by checking the weights on scales, while weighers are under actual operation, show that the results obtained by its use are much more accurate than those obtained by hand weighing, especially when the liability of errors in reading the scales and recording the weights in the latter method is taken into account.

The College of Engineering of the University of Illinois, at the commencement exercises on June 14, 1911, conferred the bachelor's degree in engineering upon 202 men, the master's degree upon nine men and the professional degrees of civil engineer, mechanical engineer and electrical engineer upon eight, four and five men, respectively. The honorary degree of doctor of engineering was conferred upon Mr. Ralph Modjeski, bridge engineer.

The Results of the Investigations into the briquetting of lignite have just been published by the Bureau of Mines in Bulletin No. 14. Charles L. Wright, who conducted the tests and who is author of the bulletin, declares that enough testing has been done to indicate that some American lignites equal German lignites in fuel value and can probably be made into briquets on a commercial scale without the use of binding materials. This bulletin can be obtained by writing to the Director of the Bureau of Mines, Washington, D. C.

POSITION WANTED

Car Draftsman.—Car company preferred. Four years' experience with all classes of steel and wooden equipment. Address G. H. A., care American Engineer.

Mechanical Engineer or Supervisor of Apprentices.—Technical graduate with very full experience covering 16 years in shops, drawing rooms and apprentice work. Address J. S., care American Engineer.

Young Man with a practical education, and five years' experience on premium and bonus systems, desires connection with a substantial company wanting a higher shop efficiency. Best references. Address F. H. M., care American Engineer.

Mechanical Man scientifically trained, eleven years' shop and drawing room experience, and in locomotive and railway supply line. At present is assistant chief draftsman of a large manufacturing concern, but desires position as chief draftsman or designer. Address M. S. W., care American Engineer.

BOOKS

Poor's Manual of Railroads for 1911. 44th Annual Number. Cloth. 5¾ x 8½ in. 2,690 pages. Published by Poor's Railroad Manual Co., 68 William street, New York. Price $10 delivered.

In this, the 44th annual number of Poor's Manual, the innovations instituted in the 1910 edition have been continued and analytical tables permitting a comparison of the financial strength as well as the operating efficiency of the different roads are given. All information given in the manual is official.

The Spontaneous Combustion of Coal with Special Reference to Bituminous Coals of the Illinois Type, by S. W. Parr and F. W. Kressmann. Bulletin No. 46 of the Engineering Experiment Station of the University of Illinois. Copies free on application to W. F. M. Goss, Urbana, Illinois.

The Bulletin describes a series of experiments directed toward the determination of the fundamental causes underlying the spontaneous combustion of coal. These causes may be summarized as follows: (1) External sources of heat, such as contact with steam pipes, hot walls, and the impact of large masses in the process of unloading, height of piles, etc.; (2) fineness of division; (3) moisture; (4) activity of oxidizable compounds, such as iron pyrites. An historical review of the literature upon the spontaneous combustion of coal is given in the Appendix.

Proceedings of the International Railway Fuel Association. Published by the Association. D. B. Sebastian, Sec., La Salle Street Station, Chicago. Price $2.00.

At the third annual convention of this association held at Chattanooga, Tenn., papers on the following subjects were presented and discussed: Fuel investigation under the Bureau of Mines, by J. A. Holmes; How to organize a railway fuel department and its relation to other departments, by T. Duff Smith; Some results of purchasing coal on a mine-run basis, Prof. A. A. Steel; Testing of locomotive fuel, by F. O. Bunnell; The railway fuel problem in relation to railway operation, by R. Emerson; Petroleum—its origin, production and use as a locomotive fuel, by Eugene McAuliffe. The copy of the proceedings contains the full text of the papers and the discussion as well as a list of members, copy of constitution, etc.

Railway Shop Kinks. Compiled by Roy V. Wright under the direction of a committee of the International Railway General Foremen's Association. Cloth. 8½ x 11½. 290 pages. Illustrated. Published by the *Railway Age Gazette*, 83 Fulton street, New York. Price, $2.00.

During the past two years the *Railway Age Gazette* has conducted a series of prize competitions for the best collection of home-made and original shop devices, and published the contributions submitted in a special shop section constituting a part of the first issue of each month. These competitions brought out a very large number of devices of this kind used in railroad shops. These articles have now been collected, assorted and systematically arranged by R. V. Wright, Mechanical Dept. Editor, and are being issued in book form. The arrangement adopted groups all devices used in each particular department together and presents them in alphabetical order. This, when taken in conjunction with the very complete index provided, permits a quick and ready reference to any desired device.

Handy devices or kinks of this kind are of inestimable value to any railroad shop, and to have a collection as large as this available for ready reference will be greatly appreciated by all foremen and master mechanics. The articles have all been carefully revised by the compiler and each is fully illustrated, permitting the device to be easily duplicated by anyone. Full credit is given as far as possible to the original designer and to the contributor. No live shop foreman can afford to be without this book.

PERSONALS

M. Marea has resigned as master mechanic of the Toledo, St. Louis & Western R. R.

William Sharp has been appointed general car inspector of Chicago, Burlington & Quincy R. R.

R. H. Lanham has been appointed master mechanic of the Missouri Pacific Ry., with headquarters at Poplar Bluff.

F. C. Moeller has been appointed night roundhouse foreman of the Rock Island Lines at Silvis, Ill., in place of J. Fitzgerald, promoted.

W. O. Morton has been appointed night roundhouse foreman, Rock Island Lines, at Burr Oak, Ill., succeeding William Glenn, promoted.

L. L. Ulrey has been appointed foreman of the air brake department of the Chicago & Eastern Illinois Ry., with headquarters at Oaklawn, Ill.

J. Fitzgerald has been appointed machine foreman at the Forty-seventh street shops, Chicago, Rock Island Lines, succeeding George Stone, promoted.

Walter H. Donley has been appointed master mechanic of the Illinois Central R. R., with office at East St. Louis, Ill., succeeding F. G. Colwell, resigned.

W. W. Calder has been appointed general car foreman of the Baltimore & Ohio Southwestern R. R., with office at Washington, Ind., succeeding H. Marsh.

W. A. Curley, foreman of the Missouri Pacific Ry. at Poplar Bluff, Mo., has been appointed master mechanic, with office at Ferriday, La., in place of G. W. French.

D. W. Cross has been appointed acting master mechanic of the Toledo, St. Louis & Western R. R., with headquarters at Frankfort, Ind., to succeed M. Marea, resigned.

A. A. McGregor has been appointed assistant master mechanic of the Louisville & Nashville R. R., with headquarters at Evansville, Ind., succeeding J. B. Huff, deceased.

George Usherwood has been appointed supervisor of boilers of the New York Central & Hudson River R. R., with office at West Albany, succeeding F. H. Linderman, promoted.

G. W. French, master mechanic of the Missouri Pacific Ry., with office at Ferriday, La., has been transferred to Paragould, Ark., as master mechanic, succeeding R. H. Lanham.

F. G. Colwell has been appointed master mechanic of the Buffalo division of the Delaware, Lackawanna & Western R. R., with office at East Buffalo, N. Y., succeeding B. H. Hawkins, resigned.

G. F. Hess has been appointed superintendent of machinery of the Kansas City Southern Ry. and the Arkansas Western Ry., with headquarters at Kansas City, Mo., succeeding J. W. Small, resigned.

N. S. Brooks has been appointed general foreman of the Baltimore & Ohio Southwestern R. R., with headquarters at Storrs, Cincinnati, succeeding W. F. Hayes, resigned on account of ill health.

P. H. Reeves, motive power inspector of the Baltimore & Ohio Southwestern R. R., at Cincinnati, Ohio, has been appointed master mechanic, with office at Chillicothe, Ohio, succeeding George F. Hess, resigned.

William E. Rockfellow, general car foreman of the New York Central & Hudson River R. R., has been appointed superintendent of the car department of the St. Lawrence and Ontario divisions, with office at Oswego, N. Y.

H. A. Witzig has been appointed master mechanic of the Missouri Southern Ry., with office at Leeper, Mo., in charge of shops and rolling stock, succeeding to the duties of Thomas Goulding, superintendent of motive power, resigned.

H. Marsh, for seven years general car foreman of the Baltimore & Ohio Southwestern R. R., at Washington, Ind., has been appointed general car foreman of the Iowa Central Ry., with headquarters at Marshalltown, Ia., succeeding W. E. Looney, resigned.

F. A. Linderman, supervisor of boilers of the New York Central & Hudson River R. R. at West Albany, N. Y., has been appointed district superintendent of motive power of the Ontario and St. Lawrence divisions, with office at Oswego, succeeding J. O. Bradeen, resigned.

A. S. Abbott, master mechanic of the St. Louis & San Francisco Ry., at Sapulpa, Okla., has been appointed mechanical superintendent of the First district, and J. Foster, master mechanic at Kansas City, Mo., has been appointed mechanical superintendent of the Second district, both with offices at Springfield.

W. O. Thompson, master car builder of the New York Central & Hudson River R. R., at East Buffalo, N. Y., has had his authority extended and is now in charge of the territory west of Syracuse, including the St. Lawrence, Ontario and Pennsylvania divisions, and G. E. Carson, master car builder, at West Albany, has had his authority extended and is now in charge of the territory east of Syracuse, including the Hudson, Harlem and Putnam divisions.

Francis D. Casanave, who, in the capacity of special agent, represented the Pennsylvania R. R., in charge of the locomotive testing plant at the World's Fair at St. Louis, in 1904, died recently at Escot, France. Mr. Casanave was born in France in 1843 and began his railroad career as an apprentice in the shops of the Pennsylvania R. R. at Altoona in 1862. After various promotions he became assistant master mechanic of the Altoona machine shops in 1876, in which capacity he served until 1881, when he became master mechanic of the Pennsylvania Co.'s shops at Ft. Wayne, Ind. In 1887 he was made superintendent of motive power of the Northwest system, Pennsylvania Lines West. He remained in this position until 1893, when he became general superintendent of motive power of the Lines East, serving in that capacity until 1901, from which date until 1903 he was general superintendent of motive power of the Baltimore & Ohio at Baltimore, Md. Mr. Casanave retired from active participation in railroad affairs at the conclusion of his special commission with the Pennsylvania R. R. in 1905.

CATALOGS

Automatic Stop Valve.—A valve designed to automatically stop the supply of oil to the burners in case of any unusual conditions is illustrated in a leaflet sent out by the Rockwell Furnace Co., 26 Cortlandt Street, New York. It is called the Lalor Automatic Stop Valve.

Water Weigher.—Elsewhere in this issue will be found an illustrated description of the Kennicott water weigher. This apparatus has been made the subject of Bulletin No. 38 from the Kennicott Co., Chicago Heights, Ill., where excellent colored illustrations clearly show its operation. Drawings are given showing several different styles.

Gas Electric Motor Car.—The General Electric Company has just issued a very attractive publication devoted to a detailed description of its double truck type of gas-electric car. The publication is elaborately illustrated, and contains considerable data relative to the subject. It includes plans and elevations of cars of various sizes. The number of the bulletin is 4855.

Alternating Current Generators.—Bulletin No. 481 issued by the Triumph Electric Co., Cincinnati, Ohio, contains some very interesting information on the subject of direct connected alternating current generators. Illustrations showing details of construction are accompanied by full description and discussion of the reasons for the recommended practice shown.

Turret Lathes.—A booklet being sent out by the Gisholt Machine Co., Madison, Wis., is largely devoted to illustrating the surprising range of work which the turret lathe is capable of performing. Boring, turning, facing, threading and cutting operations of a difficult nature are found in the examples, in many cases on the same piece where several operations were performed simultaneously.

Steam Turbines.—In Catalog No. 19 received from the Kerr Turbine Co., Wellsville, N. Y., is given a complete illustrated description of the Kerr turbine, covering the principles and theory and operation as well as the features of construction. These turbines are made in sizes from 2 to 600 horsepower, using from two to eight stages. They are designed on the steam jet principle, with buckets which act very similar to those in a Pelton water wheel.

Small Tools.—Catalog No. 6 from Pratt & Whitney Co., Hartford, Conn., is devoted to excellent illustrations and full information, including prices of the complete line of small tools manufactured by it. The 248 page book is divided into sections, each devoted to a particular tool as follows: Taps, dies, milling cutters, reamers, punches, drills and miscellaneous tools. Valuable tables of dimensions of screw threads, etc., and a complete index occupy the last 30 pages.

Heavy Lathes.—A catalog conforming to the excellent character of its former publications is being issued by Niles-Bement-Pond Co., 111 Broadway, New York, and is devoted entirely to illustrating large size lathes by large photographs, accompanied by brief descriptive matter. Pond lathes are shown in sizes from 24 to 72 inch swing in either of three styles of drive. Bement lathes with swings from 84 inches up occupy another section. Many new features are evident in these machines.

Electrical Machinery.—An attractive publication recently issued by the General Electric Company on the subject of Motor-Generator Sets contains brief descriptions of generator sets of different styles and sizes. These sets are made up of various combinations of alternating and direct current generators and motors, and range in capacity from 95 kw. to over 7,000 kw. The number of the bulletin is 4849. The same company has also just revised its bulletin devoted to Single-Phase Repulsion Motors. This bulletin is numbered 4858.

Tool Steel.—Jessop carbon and high speed tool steels are known throughout the world and the makers endeavor to maintain their reputation by keeping in the forefront in the developments in this class of material. A booklet just being issued from the principal American warehouse, 91 John St., New York, explains the principle on which all Jessop steels are made and gives full directions for properly working each kind. Tables of prices, extra sizes, and lists of different shapes of both tool and other steels are included. A table at the back of the catalog gives the temperature corresponding to different colors of steel.

Storage Batteries.—"The Electrical Installations in the Detroit River Tunnel Plant" is the title of a new 12 page bulletin just issued by the Gould Storage Battery Co., 341 Fifth Avenue, New York. This bulletin describes the Gould battery and allied regulating apparatus by means of which current from the Detroit Edison Company's plant is made to pull Michigan Central trains through the new Detroit River Tunnel. The engineering in connection with this installation is unusual and of special interest to those having excessive peak loads.

NOTES

Official Guide.—The offices of the National Railway Publication Company, publishers of *The Official Railway Guide*, have been removed from 24 Park Place to 75 Church Street, New York City.

Pressed Steel Car Co.—N. S. Reeder, Vice-President of the Western Steel Car & Foundry Company, Chicago, Ill., has been elected Second Vice-President of the Pressed Steel Car Company. Mr. Reeder will continue his Chicago location.

Westinghouse Electric & Manufacturing Co.—Edwin M. Herr, who was elected President of the Westinghouse Electric & Manufacturing Company at a meeting of the board of directors held in New York August 1, was born in Lancaster, Pa., May 3, 1860. Upon completion of a common school course, he was given the position of telegraph operator on the Kansas Pacific Railroad, with which Company he remained for two years. In 1881 he entered the Sheffield Scientific School of Yale, graduating in the class of 1884, and worked as an apprentice in the shops of the Pennsylvania Railroad Company at Altoona, Pa., during the two summer vacations. From 1884 to 1885 he was an apprentice at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railroad. He then went to the Chicago, Burlington & Quincy Railroad Company as a draughtsman in the mechanical engineer's office, and afterwards became Assistant Engineer of Tests, and was promoted from this position to Engineer of Tests on this road at Aurora, Ill. From 1887 to 1889 he was Superintendent of Telegraphy, and from 1889 to 1890 Division Superintendent of this road. From 1890 to 1892 he was Division Master Mechanic of the Chicago, Milwaukee & St. Paul Railroad at West Milwaukee, and for the next two years was Superintendent of the Grant Locomotive Works at Chicago. From 1895 to 1897 he was Superintendent of Motive Power and Machinery of the Chicago & Northwestern Railroad, and from June 1, 1897, to September 10, 1898, he held the same position with the Northern Pacific Railroad. On September 10, 1898, he became Assistant General Manager of the Westinghouse Air Brake Company at Wilmerding, Pa. He was promoted to the position of General Manager on November 1, 1899, which position he held until June 1, 1905, when he was elected First Vice-President.

The Mountain (4-8-2) Type Passenger Locomotive

CHESAPEAKE & OHIO RAILWAY.

A SIMPLE PASSENGER LOCOMOTIVE WEIGHING 330,000 LBS. TOTAL WITH 239,000 LBS. ON FOUR PAIRS OF DRIVERS HAS BEEN DESIGNED AND AN ORDER OF TWO BUILT FOR THE CHESAPEAKE & OHIO RAILWAY BY THE AMERICAN LOCOMOTIVE COMPANY. THIS DESIGN NOT ONLY HOLDS THE RECORD FOR SIZE AND POWER OF SIMPLE LOCOMOTIVES, BUT IS THE FIRST IN REGULAR SERVICE IN THIS COUNTRY TO INCORPORATE THE SCREW REVERSE GEAR.

On the Clifton Forge Division of the Chesapeake & Ohio Railway the Pacific type locomotives in use, which have 22 by 28 in. cylinders, 72 in. drivers, 200 lbs. steam pressure, total heating surface of 3,737 sq. ft. and weigh 216,000 lbs. total, with 157,700 lbs. on drivers, are able to maintain the schedule of 25.5 m. p. h. west bound and 33 m. p. h. east bound, with a maximum of six cars weighing 350 tons. Since the traffic on these trains frequently requires ten or twelve cars it has been necessary to double head with great regularity.

Recently two locomotives have been put into service, one of which will comfortably handle a twelve-car train over this division on the same schedule. As can be readily surmised, these locomotives are unusually powerful machines and as a matter of fact they not only are the largest passenger locomotives, excepting the Mallet of the Santa Fe, but are also the largest and most powerful simple locomotives ever built.

LARGEST SIMPLE LOCOMOTIVE, INTRODUCING A NEW TYPE OF WHEEL ARRANGEMENT.

The engineers of the American Locomotive Company, after making a careful and extended study of all conditions, etc., found the service could be performed by a simple locomotive, but that it would be necessary to introduce a new wheel arrangement, viz., 4-8-2 type. This type has been named by J. F. Walsh, superintendent of motive power, the "mountain" type. The design was prepared by the builders in collaboration with the motive power officials of the company and even a cursory examination of the illustrations and data given herewith will show it to be worthy of the admiration of every champion of progressive, sound, and clean-cut locomotive design.

The great power of these locomotives is best indicated by comparison with the next largest simple locomotive on our records and with the class K3 Pacific type passenger locomotive on the New York Central Lines. The table in the next column will permit of such comparison.

Since going into service these two locomotives have proven to be all that was expected. They are at present assigned regularly to trains 2, 3, 4 and 5, the odd numbers being west bound, which have the schedules mentioned above of 25.5 m. p. h. west bound and 33 m. p. h. east bound, including stops, of which No. 3 makes four, No. 5 seven, No. 4 two, and No. 2 two to five. As shown on the profile, the grades are very heavy in both directions, the worst being against west bound traffic. On the 14 mile 75 ft. grade from Meechum's River to Afton there are uncompensated curves of 10 degs., giving an equivalent grade of 1.82 per cent. This grade and the 7 mile, 80 ft. grade, by which the summit of the division is reached, are the most difficult parts of the road and the new locomotives are designed to give sufficient power to maintain a speed on this section of 25 m. p. h. with a 600 ton train, and as a matter of fact they have considerably exceeded it. On a number of days since being in regular service, both of these locomotives have made the run from Charlottesville to Clifton Forge, with trains of approximately 700 tons, in considerably better than schedule time. In one case, with a train of 636 tons, 21 minutes was made up over the division and in another case, with a train of 700 tons, eight minutes was made up. On the Allegheny District of the Hinton Division, from Hinton to Clifton Forge, a distance of 80 miles, many similar records have been made. In the matter of speed the locomotives have shown themselves to be unusually capable. On one occasion, with a 10-car train, 2.4 miles, over a level track, was negotiated in two minutes flat, giving a speed of 72 m. p. h. On July 13, with a light train of seven coaches,

	C. & O.	B. & O.	N. Y. C
Type	4-8-2	2-8-2	4-6-2
Total weight, lbs.	330,000	274,600	269,000
Weight on drivers, lbs.	239,000	219,000	171,500
Average weight per driving axle, lbs.	59,750	54,750	57,167
Tractive effort, lbs.	58,000	50,200	30,900
Cylinders, in.	29x28	24x32	23½x26
Steam pressure, lbs.	180	205	200
Diam. drivers, in.	62	64	79
Diam. of boiler at front ring, in.	83¾	78	72
Number and size of tubes	243-2¼	389-2¼	175-2¼
	40-5½	.....	32-5½
Evaporative heating surface, total sq. ft.	4,132	5,017	3,424.1
Superheater heating surface, sq. ft.	845	.....	765
Grate area, sq. ft.	66.7	70	56.5
Reference for description in this JOURNAL	....	Apr. '11	Apr. '11

which had a schedule of 3 hrs. and 20 min. over the division, the run was made in 2 hrs. and 39 min., 29 stops being made, and speeds of approximately 58 m. p. h. being obtained between stops. As an example of the sustained power of the locomotive

N. S. Brooks has been appointed general foreman of the Baltimore & Ohio Southwestern R. R., with headquarters at Storrs, Cincinnati, succeeding W. E. Hayes, resigned on account of ill health.

P. H. Reeves, motive power inspector of the Baltimore & Ohio Southwestern R. R., at Cincinnati, Ohio, has been appointed master mechanic, with office at Chillicothe, Ohio, succeeding George F. Hess, resigned.

William E. Rockfellow, general car foreman of the New York Central & Hudson River R. R., has been appointed superintendent of the car department of the St. Lawrence and Ontario divisions, with office at Oswego, N. Y.

H. A. Witzig has been appointed master mechanic of the Missouri Southern Ry., with office at Leeper, Mo., in charge of shops and rolling stock, succeeding to the duties of Thomas Goulding, superintendent of motive power, resigned.

H. Marsh, for seven years general car foreman of the Baltimore & Ohio Southwestern R. R., at Washington, Ind., has been appointed general car foreman of the Iowa Central Ry., with headquarters at Marshalltown, Ia., succeeding W. E. Looney, resigned.

F. A. Linderman, supervisor of boilers of the New York Central & Hudson River R. R. at West Albany, N. Y., has been appointed district superintendent of motive power of the Ontario and St. Lawrence divisions, with office at Oswego, succeeding J. O. Bradeen, resigned.

A. S. Abbott, master mechanic of the St. Louis & San Francisco Ry., at Sapulpa, Okla., has been appointed mechanical superintendent of the First district, and J. Foster, master mechanic at Kansas City, Mo., has been appointed mechanical superintendent of the Second district, both with offices at Springfield.

W. O. Thompson, master car builder of the New York Central & Hudson River R. R., at East Buffalo, N. Y., has had his authority extended and is now in charge of the territory west of Syracuse, including the St. Lawrence, Ontario and Pennsylvania divisions, and G. E. Carson, master car builder, at West Albany, has had his authority extended and is now in charge of the territory east of Syracuse, including the Hudson, Harlem and Putnam divisions.

Francis D. Casanave, who, in the capacity of special agent, represented the Pennsylvania R. R., in charge of the locomotive testing plant at the World's Fair at St. Louis, in 1904, died recently at Escot, France. Mr. Casanave was born in France in 1843 and began his railroad career as an apprentice in the shops of the Pennsylvania R. R. at Altoona in 1862. After various promotions he became assistant master mechanic of the Altoona machine shops in 1876, in which capacity he served until 1881, when he became master mechanic of the Pennsylvania Co.'s shops at Ft. Wayne, Ind. In 1887 he was made superintendent of motive power of the Northwest system, Pennsylvania Lines West. He remained in this position until 1893, when he became general superintendent of motive power of the Lines East, serving in that capacity until 1901, from which date until 1903 he was general superintendent of motive power of the Baltimore & Ohio at Baltimore, Md. Mr. Casanave retired from active participation in railroad affairs at the conclusion of his special commission with the Pennsylvania R. R. in 1905.

CATALOGS

Automatic Stop Valve.—A valve designed to automatically stop the supply of oil to the burners in case of any unusual conditions is illustrated in a leaflet sent out by the Rockwell Furnace Co., 26 Cortlandt Street, New York. It is called the Lalor Automatic Stop Valve.

Water Weigher.—Elsewhere in this issue will be found an illustrated description of the Kennicott water weigher. This apparatus has been made the subject of Bulletin No. 38 from the Kennicott Co., Chicago Heights, Ill., where excellent colored illustrations clearly show its operation. Drawings are given showing several different styles.

Gas Electric Motor Car.—The General Electric Company has just issued a very attractive publication devoted to a detailed description of its double-truck type of gas-electric car. The publication is elaborately illustrated, and contains considerable data relative to the subject. It includes plans and elevations of cars of various sizes. The number of the bulletin is 4555.

Alternating Current Generators.—Bulletin No. 481 issued by the Triumph Electric Co., Cincinnati, Ohio, contains some very interesting information on the subject of direct connected alternating current generators. Illustrations showing details of construction are accompanied by full description and discussion of the reasons for the recommended practice shown.

Turret Lathes.—A booklet being sent out by the Gisholt Machine Co., Madison, Wis., is largely devoted to illustrating the surprising range of work which the turret lathe is capable of performing. Boring, turning, facing, threading and cutting operations of a difficult nature are found in the examples, in many cases on the same piece where several operations were performed simultaneously.

Steam Turbines.—In Catalog No. 19 received from the Kerr Turbine Co., Wellsville, N. Y., is given a complete illustrated description of the Kerr turbine, covering the principles and theory and operation as well as features of construction. These turbines are made in sizes from 2 to [illegible] horsepower, using from two to eight stages. They are designed on the steam jet principle, with buckets which act very similar to those of a Pelton water wheel.

Small Tools.—Catalog No. 6 from Pratt & Whitney Co., Hartford, Conn., is devoted to excellent illustrations and full information, including prices of the complete line of small tools manufactured by it. The 24[illegible] book is divided into sections, each devoted to a particular tool as [illegible] Taps, dies, milling cutters, reamers, punches, drills and miscellaneous t[illegible] Valuable tables of dimensions of screw threads, etc., and a complete [illegible] occupy the last 30 pages.

Heavy Lathes.—A catalog conforming to the excellent character of former publications is being issued by Niles-Bement-Pond Co., 111 Broadway, New York, and is devoted entirely to illustrating large size [illegible] by large photographs, accompanied by brief descriptive matter. [illegible] lathes are shown in sizes from 24 to 72 inch swing in either a three st[illegible] or drive. Bement lathes with swings from 84 inches up occupy a [illegible] section. Many new features are evident in these machines.

Electrical Machinery.—An attractive publication recently issued by [the] General Electric Company on the subject of Motor-Generator Sets contains brief descriptions of generator sets of different styles and sizes. [illegible] sets are made up of various combinations of alternating and direct current generators and motors, and range in capacity from 65 kw. to over [illegible] kw. The number of the bulletin is 4849. The same company has just revised its bulletin devoted to Single-Phase Repulsion Motors. [illegible] bulletin is numbered 4858.

Tool Steel.—Jessop carbon and high speed tool steels are k[nown] throughout the world and the makers endeavor to maintain their reput[ation] by keeping in the forefront in the developments in this class of mat[erial]. A booklet just being issued from the principal American warehouse [illegible] John St., New York, explains the principle on which all Jessop steels [are] made and gives full directions for properly working each kind. Tables [of] prices, extra sizes, and lists of different shapes of both tool and [illegible] steels are included. A table at the back of the catalog gives the tempera[tures] corresponding to different colors of steel.

Storage Batteries.—"The Electrical Installations in the Detroit R[iver] Tunnel Plant" is the title of a new 12 page bulletin just issued by [the] Gould Storage Battery Co., 341 Fifth Avenue, New York. This bulle[tin] describes the Gould battery and allied regulating apparatus by means [of] which current from the Detroit Edison Company's plant is made to [illegible] Michigan Central trains through the new Detroit River Tunnel. The [illegible] engineering in connection with this installation is unusual and of special [in]terest to those having excessive peak loads.

NOTES

Official Guide.—The offices of the National Railway Publication C[om]pany, publishers of *The Official Railway Guide*, have been removed [from] 24 Park Place to 75 Church Street, New York City.

Pressed Steel Car Co.—N. S. Reeder, Vice-President of the West[ern] Steel Car & Foundry Company, Chicago, Ill., has been elected Se[cond] Vice President of the Pressed Steel Car Company. Mr. Reeder will [con]tinue his Chicago location.

Westinghouse Electric & Manufacturing Co.—Edwin M. Herr, [who] was elected President of the Westinghouse Electric & Manufacturing C[om]pany at a meeting of the board of directors held in New York Augus[t], was born in Lancaster, Pa., May 3, 1860. Upon completion of a com[mon] school course, he was given the position of telegraph operator on the K[an]sas Pacific Railroad, with which Company he remained for two years. [In] 1881 he entered the Sheffield Scientific School of Yale, graduating in [the] class of 1884, and worked as an apprentice in the shops of the Penn[syl]vania Railroad Company at Altoona, Pa., during the two summer va[ca]tions. From 1884 to 1885 he was an apprentice at the West Milwauk[ee] shops of the Chicago, Milwaukee & St. Paul Railroad. He then went [to] the Chicago, Burlington & Quincy Railroad Company as a draughtsman [in] the mechanical engineer's office, and afterwards became Assistant Engin[eer] of Tests, and was promoted from this position to Engineer of Tests on t[he] road at Aurora, Ill. From 1887 to 1889 he was Superintendent of T[ele]graphy, and from 1889 to 1890 Division Superintendent of this [road]. From 1890 to 1892 he was Division Master Mechanic of the Chicago, M[il]waukee & St. Paul Railroad at West Milwaukee, and for the next t[wo] years was Superintendent of the Grant Locomotive Works at Chicag[o]. From 1895 to 1897 he was Superintendent of Motive Power and Machin[ery] of the Chicago & Northwestern Railroad, and from June 1, 1897, [to] September 10, 1898, he held the same position with the Northern Paci[fic] Railroad. On September 10, 1898, he became Assistant General Manager [of] the Westinghouse Air Brake Company at Wilmerding, Pa. He was pr[o]moted to the position of General Manager on November 1, 1899, wh[ich] position he held until June 1, 1905, when he was elected First Vi[ce] President.

The Mountain (4-8-2) Type Passenger Locomotive

CHESAPEAKE & OHIO RAILWAY.

A SIMPLE PASSENGER LOCOMOTIVE WEIGHING 330,000 LBS. TOTAL WITH 239,000 LBS. ON FOUR PAIRS OF DRIVERS HAS BEEN DESIGNED AND AN ORDER OF TWO BUILT FOR THE CHESAPEAKE & OHIO RAILWAY BY THE AMERICAN LOCOMOTIVE COMPANY. THIS DESIGN NOT ONLY HOLDS THE RECORD FOR SIZE AND POWER OF SIMPLE LOCOMOTIVES, BUT IS THE FIRST IN REGULAR SERVICE IN THIS COUNTRY TO INCORPORATE THE SCREW REVERSE GEAR

On the Clifton Forge Division of the Chesapeake & Ohio Railway the Pacific type locomotives in use, which have 22 by 28 in. cylinders, 72 in. drivers, 200 lbs. steam pressure, total heating surface of 3,737 sq. ft. and weigh 216,000 lbs. total, with 57,700 lbs. on drivers, are able to maintain the schedule of 25.5 m. p. h. west bound and 33 m. p. h. east bound, with a maximum of six cars weighing 350 tons. Since the traffic on these trains frequently requires ten or twelve cars it has been necessary to double head with great regularity.

Recently two locomotives have been put into service, one of which will comfortably handle a twelve-car train over this division on the same schedule. As can be readily surmised, these locomotives are unusually powerful machines and as a matter of fact they not only are the largest passenger locomotives, excepting the Mallet of the Santa Fe, but are also the largest and most powerful simple locomotives ever built.

The engineers of the American Locomotive Company, after making a careful and extended study of all conditions, etc., found the service could be performed by a simple locomotive, but that it would be necessary to introduce a new wheel arrangement, viz., 4-8-2 type. This type has been named by J. F. Walsh, superintendent of motive power, the "mountain" type. The design was prepared by the builders in collaboration with the motive power officials of the company and even a cursory examination of the illustrations and data given herewith will show it to be worthy of the admiration of every champion of progressive, sound, and clean-cut locomotive design.

The great power of these locomotives is best indicated by comparison with the next largest simple locomotive on our records and with the class K3 Pacific type passenger locomotive on the New York Central Lines. The table in the next column will permit of such comparison.

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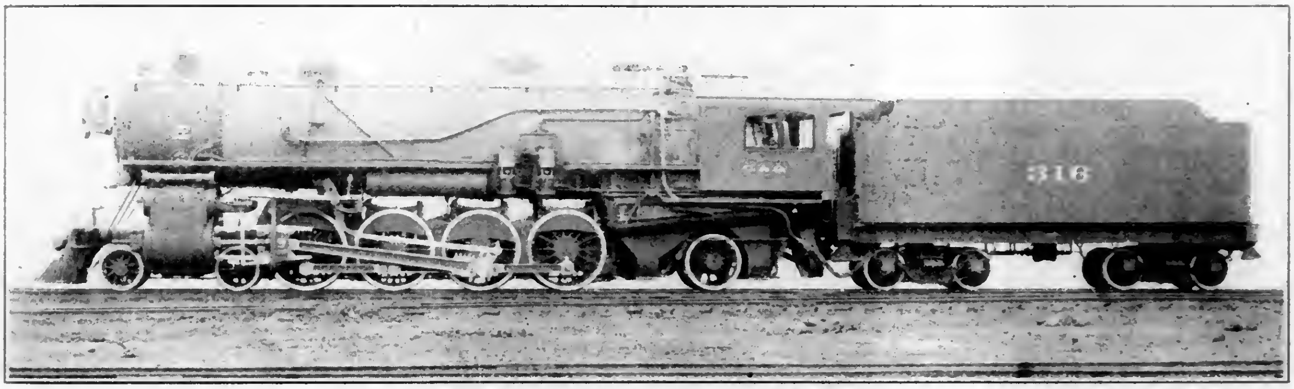
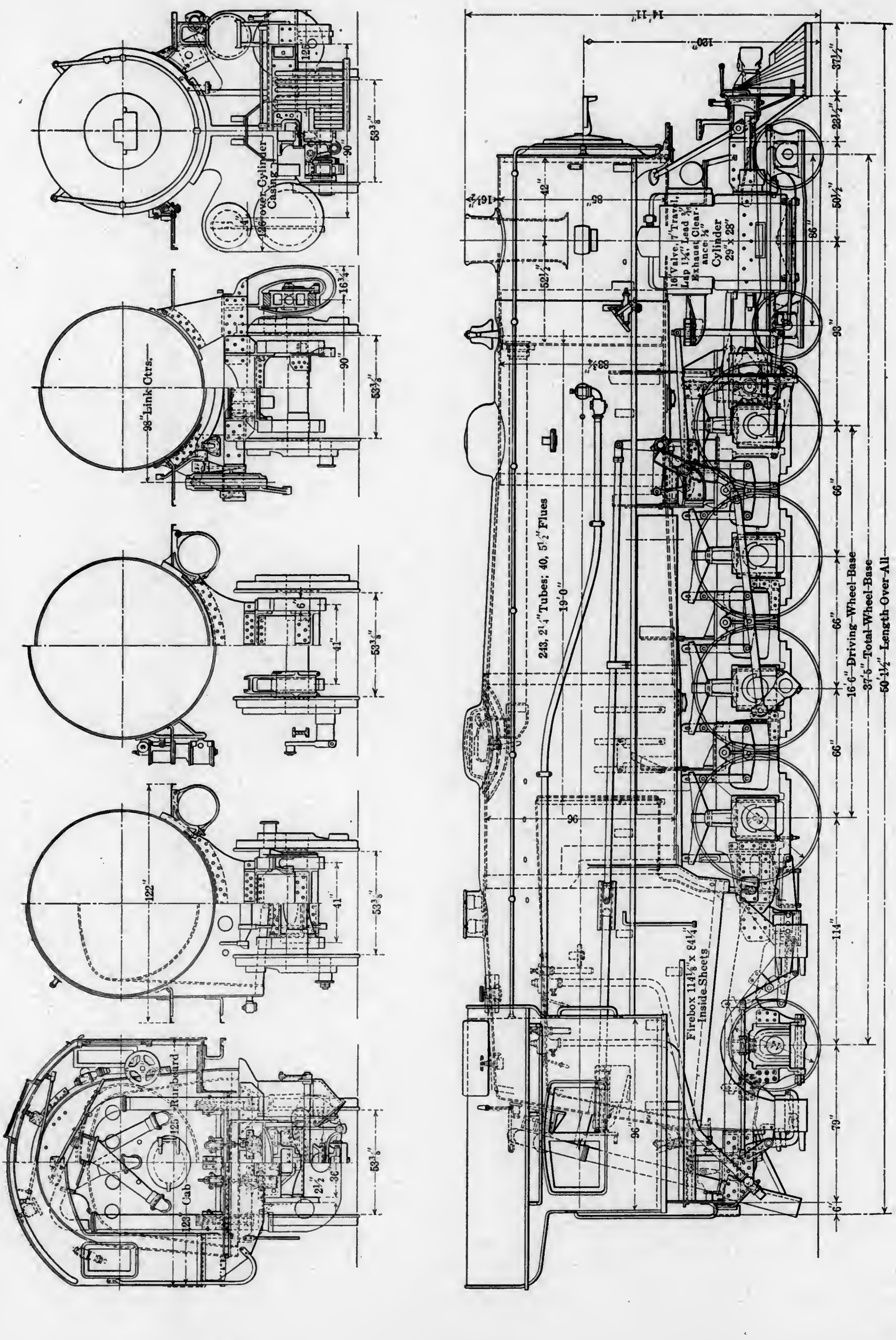


LARGEST SIMPLE LOCOMOTIVE, INTRODUCING A NEW TYPE OF WHEEL ARRANGEMENT.

	C. & O.	B. & O.	N. Y. C.
Type	4-8-2	2-8-2	4-6-2
Total weight, lbs.	330,000	274,600	269,000
Weight on drivers, lbs.	239,000	219,000	171,500
Average weight per driving axle, lbs.	59,750	54,750	57,167
Tractive effort, lbs.	58,000	50,200	30,900
Cylinders, in.	29x28	24x32	23½x26
Steam pressure, lbs.	180	205	200
Diam. drivers, in.	62	64	79
Diam. of boiler at front ring, in.	83¾	78	72
Number and size of tubes	243-2¼	389-2¼	175-2¼
	40-5½	.....	32-5½
Evaporative heating surface, total sq. ft.	4,132	5,017	3,424.1
Superheater heating surface, sq. ft.	845	.....	765
Grate area, sq. ft.	66.7	70	56.5
Reference for description in this Journal	....	Apr. '11	Apr. '11



THE "MOUNTAIN" TYPE PASSENGER LOCOMOTIVE FOR CHESAPEAKE AND OHIO RAILWAY.

performance in handling a train of 4,200 tons on a grade of 15 ft. to the mile, at the rate of 23.5 m. p. h., is striking. In fact, in all respects the work of the locomotives in service have more than met the expectations of the railway company and the builders.

Boiler.

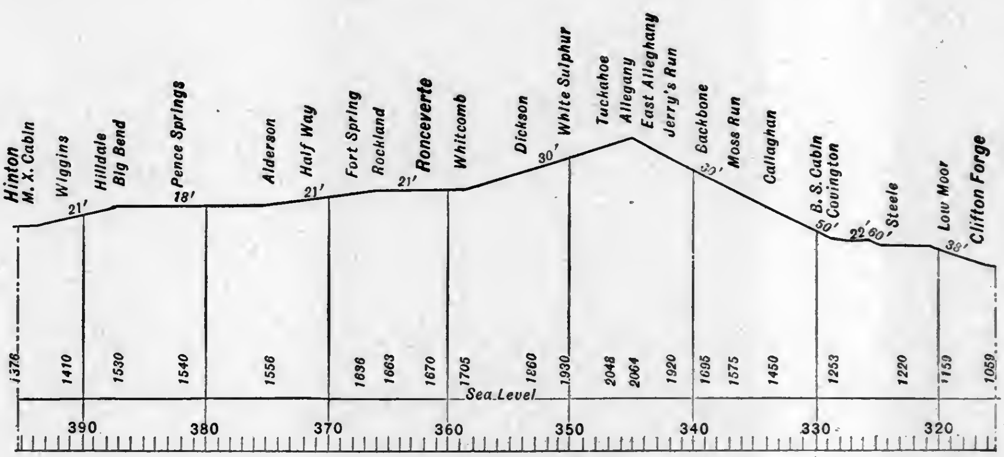
No better proof can be given of the boiler capacity of this locomotive than the work it did in hauling the train of 4,200 tons mentioned above. Assuming a resistance of 9 lbs. per ton, which is probably conservative, the draw bar pull required for this train would be 37,800 lbs., and at 23.5 miles per hour this would give a draw bar h.p. of 2,350 and an indicated h.p. of about 2,600 with a 90 per cent. machine efficiency. At a water rate of 21 lbs. per h.p. hour this requires the evaporation of 54,810 lbs. of water per hour or about 13¼ lbs. per square foot of heating surface per hour. At a rate of 3¼ lbs. of coal per draw bar h.p. this speed sustained on this grade would require about 7,600 lbs. of coal per hour or 114 lbs. per square foot of grate. This, of course, puts the locomotive out of the hand-fired class and it is only the stoker that permits it to develop so large a boiler capactiy.

In construction the boiler does not differ particularly from customary design,, being of the conical type 83¾ in. in diameter at the front ring and 96 in. diameter at the largest point, having 19 ft. tubes and a combustion chamber of 3 ft. 6 in. in length. There are 243 2¼ in. tubes and 40 5½ in. tubes, giving an evaporative heating surface of 3,795 sq. ft., which, together with the firebox, gives a total evaporative heating surface of 4,132 sq. ft., or about the same as has been used on the larger consolidation locomotives and many of the large Pacific type engines which are not equipped with superheaters. It is of the radial stayed type having a firebox 84¼ in. wide, the inner firebox sheet sloping slightly inward. One of the detailed illustrations shows the construction at the dome, where it is seen that the inner reinforcing sheet has been flanged downward to a depth of about 5 in. at the center, acting as an interior extension to the dome proper and assisting in obtaining dryer steam. A 9 in. dry pipe with a throttle of corresponding size has been applied on these locomotives.

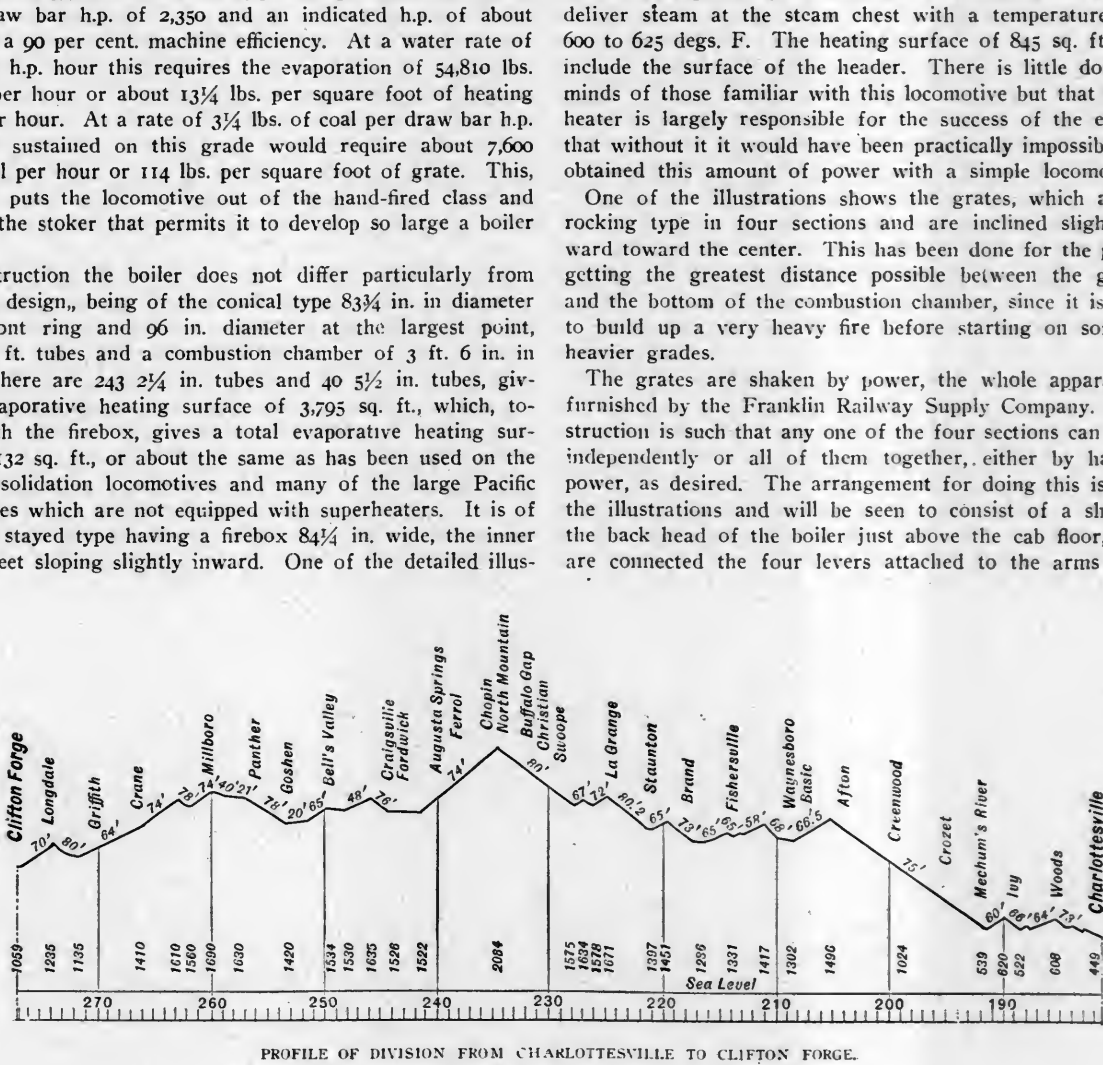
The superheater is of the regular Schmidt design, furnished by the Locomotive Superheater Company. It has 40 elements, each being on the double loop system formed of four lines of 1 7/16 in. tubes, No. 9 B. W. G. in thickness. These elements extend to a point 24 in. from the back tube sheet and should deliver steam at the steam chest with a temperature of from 600 to 625 degs. F. The heating surface of 845 sq. ft. does not include the surface of the header. There is little doubt in the minds of those familiar with this locomotive but that the superheater is largely responsible for the success of the engine and that without it it would have been practically impossible to have obtained this amount of power with a simple locomotive.

One of the illustrations shows the grates, which are of the rocking type in four sections and are inclined slightly downward toward the center. This has been done for the purpose of getting the greatest distance possible between the grate level and the bottom of the combustion chamber, since it is necessary to build up a very heavy fire before starting on some of the heavier grades.

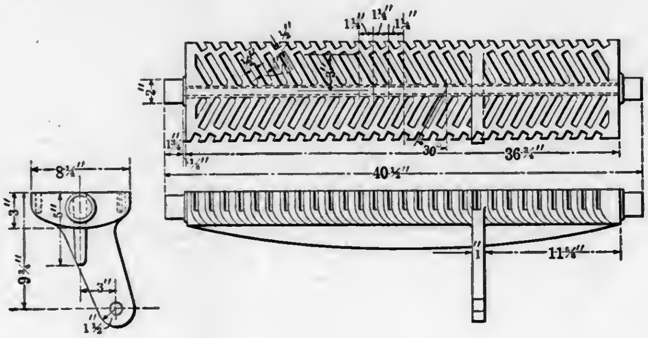
The grates are shaken by power, the whole apparatus being furnished by the Franklin Railway Supply Company. The construction is such that any one of the four sections can be shaken independently or all of them together,. either by hand or by power, as desired. The arrangement for doing this is shown in the illustrations and will be seen to consist of a shaft across the back head of the boiler just above the cab floor, to which are connected the four levers attached to the arms from the



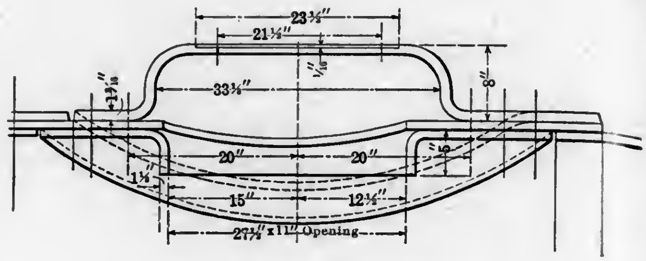
PROFILE OF DIVISION FROM CLIFTON FORGE TO HINTON.



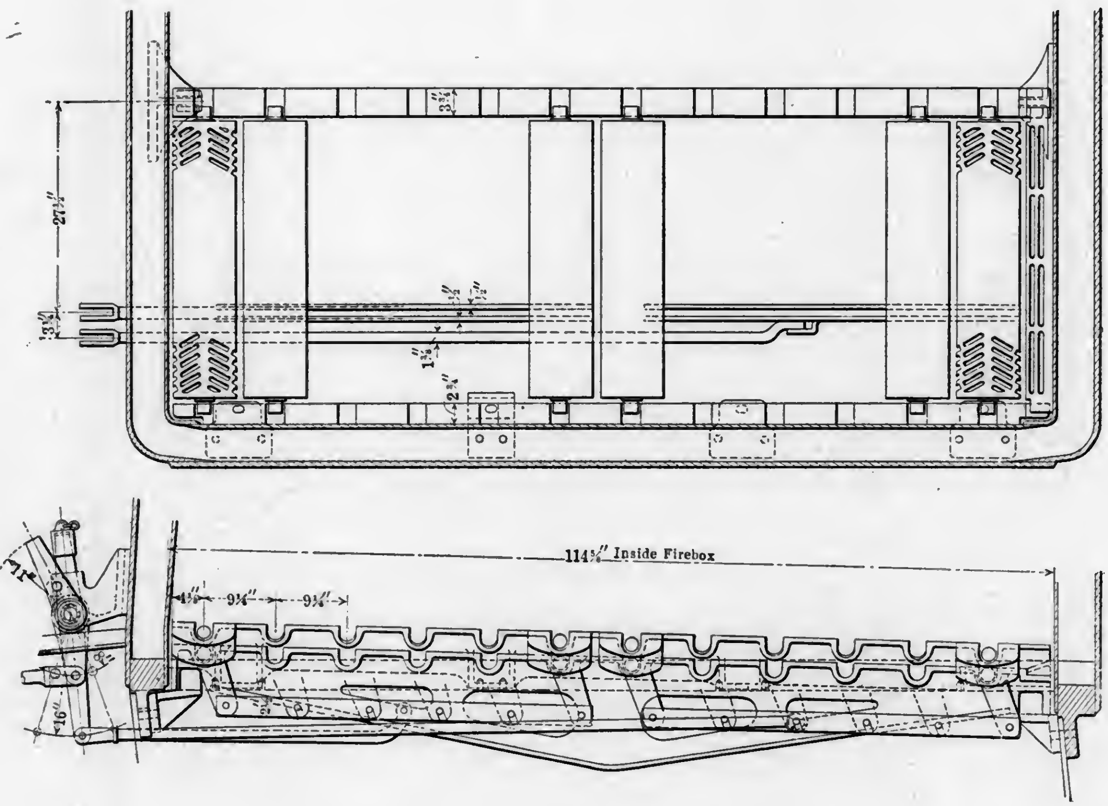
PROFILE OF DIVISION FROM CHARLOTTESVILLE TO CLIFTON FORGE.



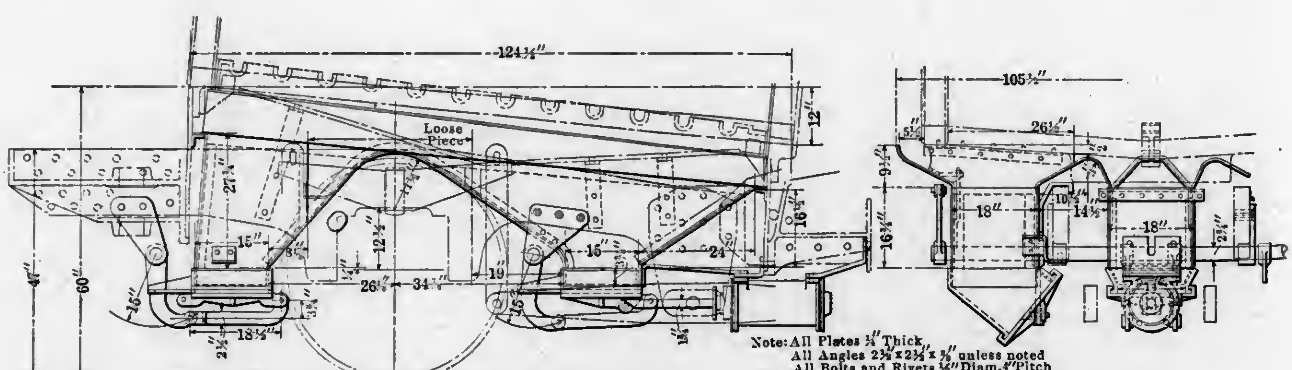
DETAIL OF GRATE BAR.



CONSTRUCTION OF BOILER AT DOME.

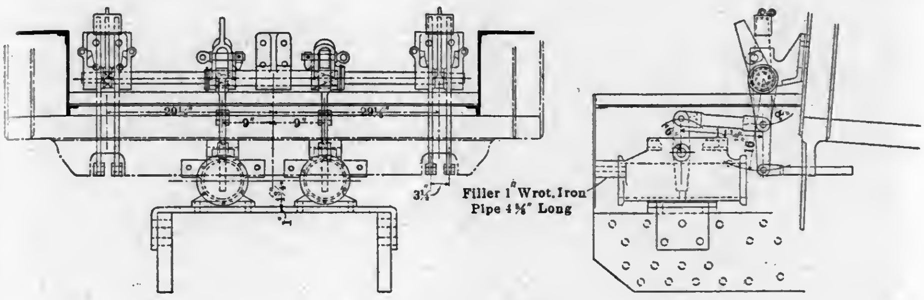


ARRANGEMENT OF GRATES AND SHAKING CONNECTIONS.



SIX-HOPPER ASH PAN HAVING 83 CUBIC FEET CAPACITY.

different sections of the grates. These shaking levers have a loose fit on the shaft and either of them can be operated by hand. Between each pair it will be seen that there is an arm extending upward from the shaft, on which it has a squared fit and a cap is provided which can be slipped over the top of this and one or both of the shaker levers. Thus when the shaft is oscillated the movement will be communicated to as many of



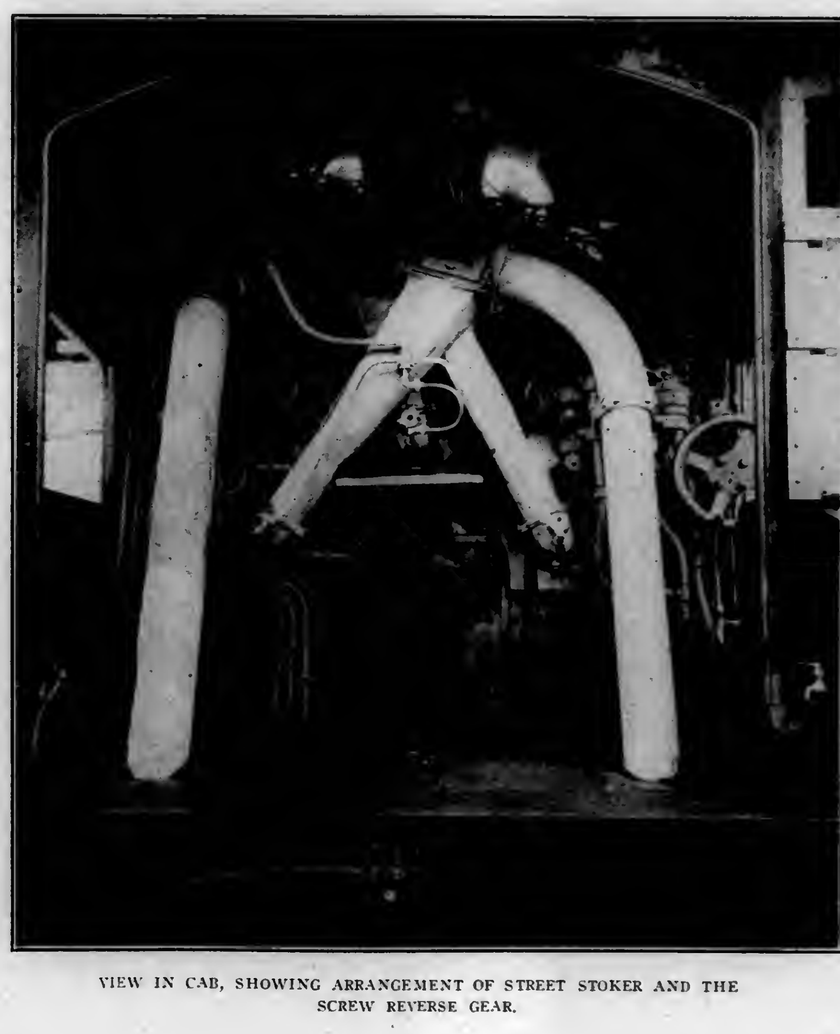
POWER GRATE SHAKER.

the shaker levers as desired. Below the cab floor there are two 6 in. cylinders, each fitted with a double piston having a slot in its center into which extends, through an opening in the side of the cylinder, one end of the rocker arm connected through a link to an arm loosely carried on the shaft. Around the upper end of this rocker arm is a U-shaped forging, having a square fit on the shaft and provided with a key, which passes through an opening in the loosely supported arm. Thus when more than one section of the grates are to be shaken by hand the pins from the power operating gear are removed and the caps put over the tops of such sections as it is desired to shake and the whole arm is oscillated by hand. When the power gear is used the pins are inserted and the cylinders oscillate the shaft, shaking such sections of the grates as are desired. The control of the shaking apparatus is located in a double valve with two operating levers, which is placed on the back head of the boiler, the pipe connection being such that steam is admitted to one and the other end ot the cylinders as the operating handle is thrown from one side to the other. In case steam pressure is not available air pressure can be used for operating the apparatus.

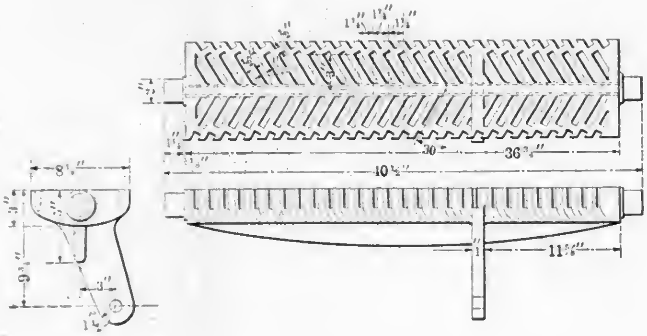
As can be readily seen by the amount of coal burned when the locomotive is working at its full capacity, it is very necessary to have a maximum ash pan capacity if runs of any length are to be made, therefore the designers have evolved an unusual and excellent arrangement in this case, which consists of six separate hoppers, all of them being dumped from one power operated gear. This pan has a capacity of nearly 83 cu. ft. as compared with about 55 cu. ft. for the ash pan on a large Pacific type locomotive. The details of the construction of the pan are clearly shown in one of the illustrations. It will be seen that it is entirely self-clearing and that a cylinder of large size is provided for moving the slides. A novelty is introduced in connection with the air inlets at the mud rings, where in place of the ordinary vertical opening underneath the ring covered with netting, the pan in this case has been extended out 5½ in. from the mud ring and brought up to the same level, leaving a horizontal opening of this dimension on both sides. As is shown in the photograph the overflow from the injectors has been split and discharges into the front and back hoppers of the pan at both sides. Since, of course, the locomotives operate in a mild climate this arrangement is feasible and advisable.

The Street locomotive stoker applied to these locomotives differs slightly from that illustrated and described on page 232 of the June issue. This change being in connection with the passage from the conveyors to the distributing nozzles. The stoker in other respects is the same as that shown. In this case the coal upon being emptied from the bucket conveyor falls upon a screen, which can be rotated to get different size openings to correspond with the quality of coal being used, and such coal as will pass through the openings falls into the passage to the center nozzle, the finer coal thus all being put into the firebox at the back end. Such coal as will not pass through the screen slides downward and is discharged into the two side pipes. A distributing device, arranged across the engine so that the rolling of the locomotive or the angularity of the track will not affect it, controls the distribution between these two nozzles. One of the illustrations shows a view in the cab which clearly illustrates this arrangement.

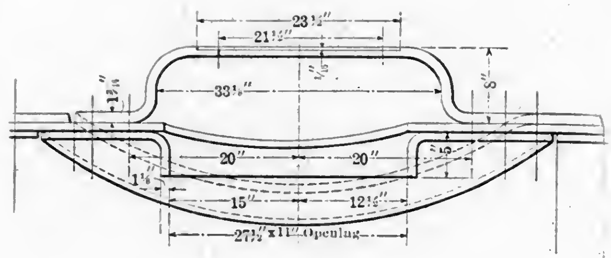
In the front end, the arrangement has been greatly simplified by the use of the steam pipes passing out through the side of the smoke box to the top of the steam chest. A comparatively low exhaust nozzle having a tip with a minimum diameter of 7⅜ in. is used in connection with a long straight interior extension



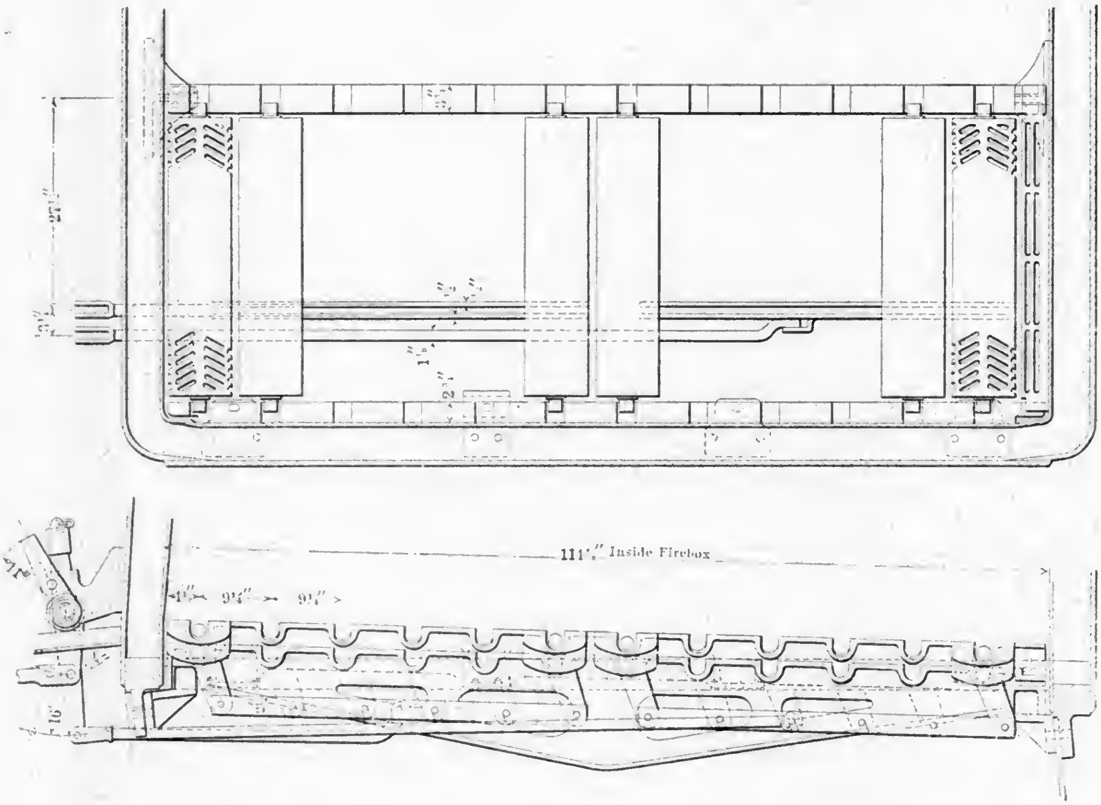
VIEW IN CAB, SHOWING ARRANGEMENT OF STREET STOKER AND THE SCREW REVERSE GEAR.



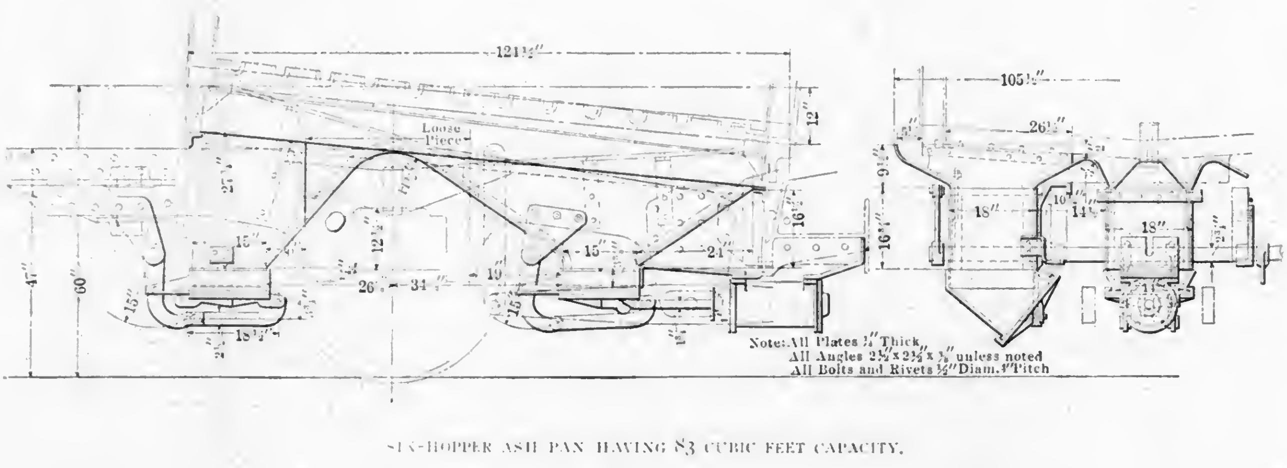
DETAIL OF GRATE BAR.



CONSTRUCTION OF BOILER AT DOME.

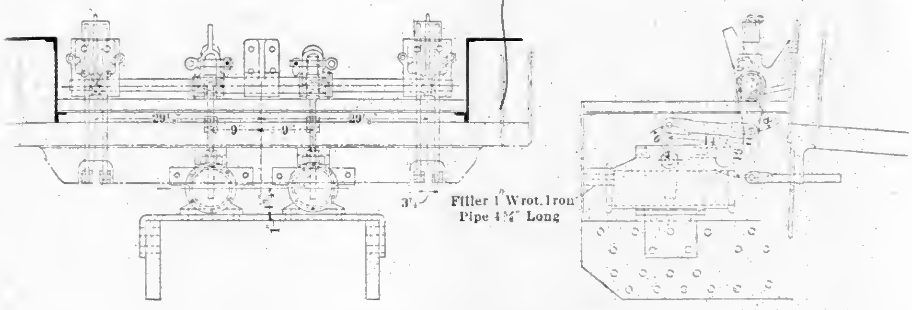


ARRANGEMENT OF GRATES AND SHAKING CONNECTIONS.



SIX-HOPPER ASH PAN HAVING 83 CUBIC FEET CAPACITY.

fferent sections of the grates. These shaking levers have a ose fit on the shaft and either of them can be operated by nd. Between each pair it will be seen that there is an arm tending upward from the shaft, on which it has a squared fit d a cap is provided which can be slipped over the top of this d one or both of the shaker levers. Thus when the shaft is cillated the movement will be communicated to as many of



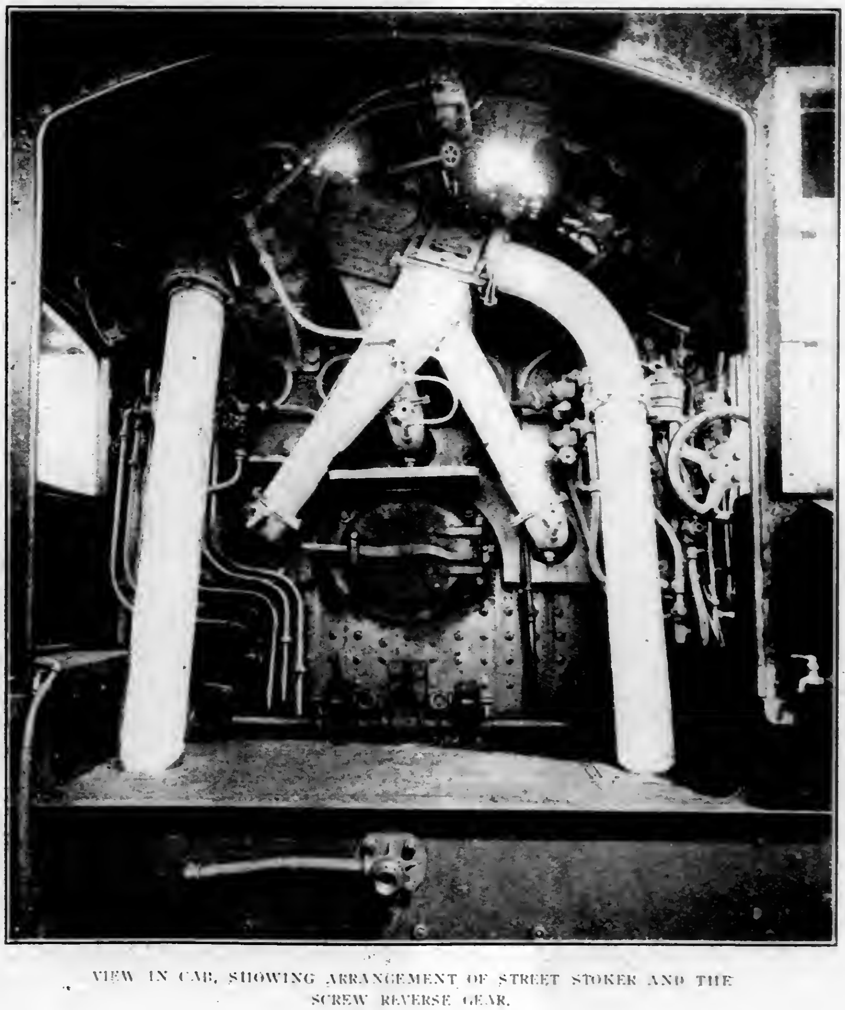
POWER GRATE SHAKER.

he shaker levers as desired. Below the cab floor there are two in. cylinders, each fitted with a double piston having a slot in ts center into which extends, through an opening in the side of he cylinder, one end of the rocker arm connected through a link to an arm loosely carried on the shaft. Around the upper end of this rocker arm is a U-shaped forging, having a square t on the shaft and provided with a key, which passes through n opening in the loosely supported arm. Thus when more than one section of the grates are to be shaken by hand the pins from the power operating gear are removed and the caps put over the tops of such sections as it is desired to shake and the whole arm is oscillated by hand. When the power gear is used the pins are inserted and the cylinders oscillate the shaft, shaking such sections of the grates as are desired. The control of the shaking apparatus is located in a double valve with two operating levers, which is placed on the back head of the boiler, the pipe connection being such that steam is admitted to one and the other end of the cylinders as the operating handle is thrown from one side to the other. In case steam pressure is not available air pressure can be used for operating the apparatus.

As can be readily seen by the amount of coal burned when the locomotive is working at its full capacity, it is very necessary to have a maximum ash pan capacity if runs of any length are to be made, therefore the designers have evolved an unusual and excellent arrangement in this case, which consists of six separate hoppers, all of them being dumped from one power operated gear. This pan has a capacity of nearly 83 cu. ft. as compared with about 55 cu. ft. for the ash pan on a large Pacific type locomotive. The details of the construction of the pan are clearly shown in one of the illustrations. It will be seen that it is entirely self-clearing and that a cylinder of large size is provided for moving the slides. A novelty is introduced in connection with the air inlets at the mud rings, where in place of the ordinary vertical opening underneath the ring covered with netting, the pan in this case has been extended out 5½ in. from the mud ring and brought up to the same level, leaving a horizontal opening of this dimension on both sides. As is shown in the photograph the overflow from the injectors has been split and discharges into the front and back hoppers of the pan at both sides. Since, of course, the locomotives operate in a mild climate this arrangement is feasible and advisable.

The Street locomotive stoker applied to these locomotives differs slightly from that illustrated and described on page 232 of the June issue. This change being in connection with the passage from the conveyors to the distributing nozzles. The stoker in other respects is the same as that shown. In this case the coal upon being emptied from the bucket conveyor falls upon a screen, which can be rotated to get different size openings to correspond with the quality of coal being used, and such coal as will pass through the openings falls into the passage to the center nozzle, the finer coal thus all being put into the firebox at the back end. Such coal as will not pass through the screen slides downward and is discharged into the two side pipes. A distributing device, arranged across the engine so that the rolling of the locomotive or the angularity of the track will not affect it, controls the distribution between these two nozzles. One of the illustrations shows a view in the cab which clearly illustrates this arrangement.

In the front end, the arrangement has been greatly simplified by the use of the steam pipes passing out through the side of the smoke box to the top of the steam chest. A comparatively low exhaust nozzle having a tip with a minimum diameter of 7⅜ in. is used in connection with a long straight interior extension

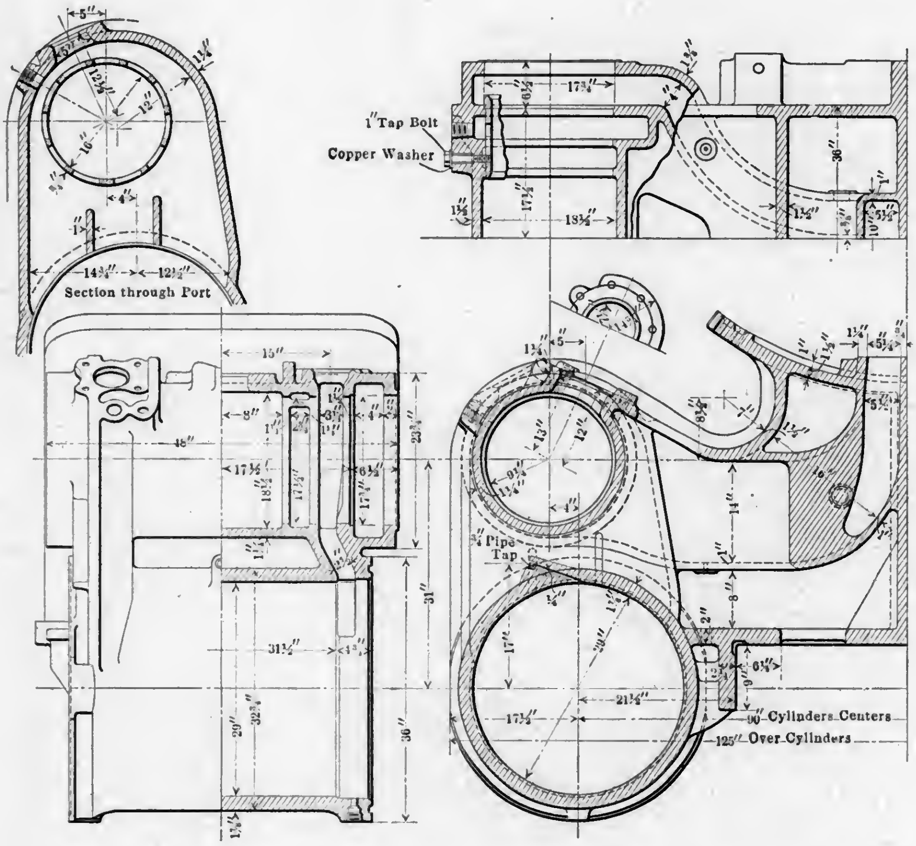


VIEW IN CAB, SHOWING ARRANGEMENT OF STREET STOKER AND THE SCREW REVERSE GEAR.

to the 20 inch stack. The front tube sheet is set well back from the center of the stack, giving ample room for the superheater.

CYLINDERS.

Simple cylinders 29 in. in diameter by 28 in. stroke are the largest ever applied to a passenger locomotive and the largest in diameter of any simple locomotive on our records. An inspection of the illustration showing the details of construction indicates that no great difficulty was experienced in designing them. The customary 90 in. centers have been obtained and because of the use of the outside steam pipes, eliminating any necessity for entrance steam passages in the saddle, the design is greatly simplified and improved Sixteen-inch piston valves are employed and the standard by-pass valve of the builders has been applied. In this case a small extra piston has been provided in the by-pass valves, acting as a cushion and preventing all slamming of the valves against their seats. It will be seen that arrangements are made for the admission of oil directly to the top of cylinder at the center.



DETAILS OF CYLINDER HAVING STEAM ADMISSION AT THE TOP OF THE STEAM CHEST.

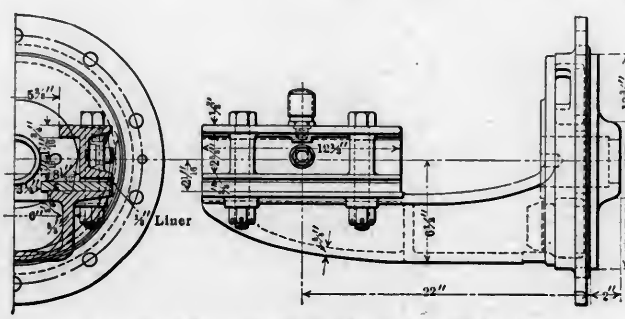
The piston rod is 4½ in. in diameter and has an extension through the front cylinder head where a suitable bearing and packing gland is provided.

VALVE GEAR.

These locomotives present the first example in regular service in this country of the use of the straightforward hand-operated screw reverse gear. The construction of this gear is shown in one of the illustrations and it will be seen that it consists simply of a steel block sliding in guides attached to the side of the boiler and threaded to receive a shaft having triple thread. 1⅛ in. pitch. It also carries an extension threaded to receive a 3 in. extra heavy iron pipe, which is carried out through the front of the cab to another block in guides to which is pinned the reach rod. A steel shaft threaded to suit the block passes through it and carries the operating wheel at the back end. Where this shaft takes a bearing in the supporting casting ball thrust bearings have been provided on either side. On this shaft is an extending ring with notches to the number of ten and a latch is provided on the upper side which, by falling into one of the notches, locks the gear in place. Since there are ten of these notches and a complete revoluton of the wheel gives a movement of 1⅛ in., it will be seen that each notch corresponds to less than ⅛ in. movement of the reach rod. A scale is secured to the top of the upper guide and a pointer, from the sliding block, indicates on it the number of inches cut-off for any particular position. This scale is stamped after the gear is in place and directly from the measurements made on the valve stem. It requires about 10 turns of the wheel to throw the engine from full gear forward to full gear backward.

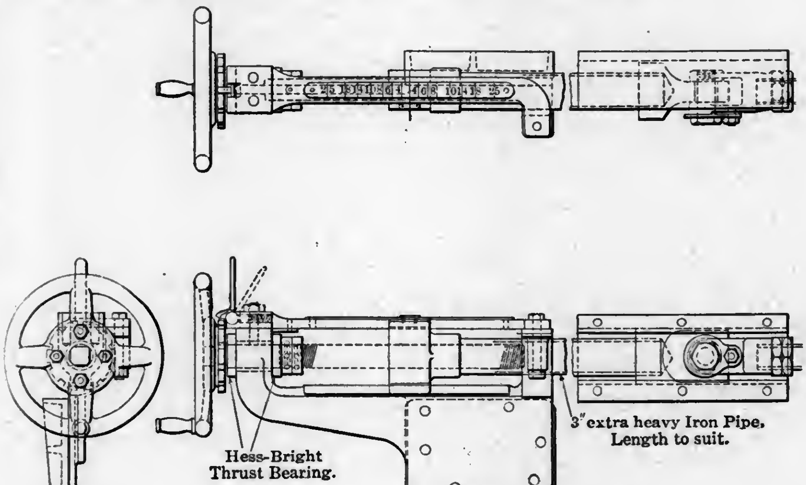
A new construction is noticed in connection with the guide carrying the valve stem crosshead. This is shown in detail below and is arranged so that all lost motion and wear can be readily taken up without dismantling the gear. The gear is arranged to give a 7 in. valve travel and the valve has a 3/16 in. lead.

The frames, which are, of course, very heavy, are made of vanadium steel. Two 9½ in. pumps have been provided on the



ADJUSTABLE GUIDE FOR VALVE STEM CROSSHEAD.

left-hand side and two reservoirs, one 20½ by 150 in., and the other 20½ by 90 in., are swung under the running board. The cylinder cocks are operated by the Hancock pneumatic gear. The front and rear trucks, the latter being of the inside journal type, are of the builders' standard practice, which has been illustrated in these columns. It will be noticed that a small running board is provided underneath the cab on either side, with a suitable handhold, permitting access to the air pumps, check valves and other parts reached from the running board without passing though the cab. The tender is large, having a capacity for 9,000 gallons of water and 15 tons of coal. It is



SCREW REVERSE GEAR.

carried on trucks fitted with the Andrews cast steel side frame. The tender frame is built up of 13 in. channels.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	58,000 lbs.
Weight in working order	330,000 lbs.
Weight on drivers	239,000 lbs.
Weight of engine and tender in working order	503,400 lbs.
Wheel base, driving	16 ft. 6 in.
Wheel base, total	37 ft. 5 in.
Wheel base, engine and tender	70 ft. 6 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.12
Total weight ÷ tractive effort	5.69
Tractive effort × diam. drivers ÷ total heating surface	870.00
Tractive effort × diam. drivers ÷ equivalent heating surface	666.00
Total heating surface ÷ grate area	61.90
Firebox heating surface ÷ total heating surface per cent	8.15
Weight on drivers ÷ total heating surface	57.90
Weight on drivers ÷ equivalent heating surface	44.30
Total weight ÷ total heating surface	80.00
Total weight ÷ equivalent heating surface	61.00
Volume both cylinders, cu. ft	21.40
Total heating surface ÷ vol. cylinders	193.00
Equivalent heating surface ÷ vol. cyls	252.00
Grate area ÷ vol. cyls	3.12

CYLINDERS.

Kind	Simple
Diameter and stroke	29 x 28 in.

VALVES

Kind	Piston
Diameter	16 in.
Greatest travel	7 in.
Outside lap	1¼ in.
Inside clearance	⅛ in.
Lead	3-16 in.

WHEELS.

Driving, diameter over tires	62 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	11½ x 14 in.
Driving journals, others, diameter and length	10½ x 14 in.
Engine truck wheels, diameter	33 in.
Engine trucks, journals	6 x 12 in.
Trailing truck wheels, diameter	44 in.
Trailing truck, journals	9 x 14 in.

BOILER.

Style	Conical
Working pressure	180 lbs.
Outside diameter of first ring	83 ¾ in.
Firebox, length and width	114⅛ x 84¼ in.
Firebox plate, thickness	⅜ x ½ in.
Firebox, water space	F-5, S. & B-4½ in.
Tubes, number and outside diameter	243-2¼, 40-5½ in.
Tubes, length	19 ft.
Heating surface, tubes	3,795 sq. ft.
Heating surface, firebox	337 sq. ft.
Heating surface, total	4,132 sq. ft.
Superheater heating surface	845 sq. ft.
Grate area	66.7 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	179 in.
Center of boiler above rail	120 in.

TENDER.

Frame	13 in. chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	15 tons

THE TURBINE LOCOMOTIVE

The turbine locomotive is now being developed elsewhere than at Glasgow. A small locomotive fitted with specially designed turbines has been successfully tried at Milan. The peculiar feature of the turbine is the use of movable blades, which are operated in series. Four sets of such blades are used, and at high speed the steam strikes the first set of blades only, while at intermediate speeds two sets or three sets can come into play. The reversing mechanism is a special and unique feature of this motor. The rotors have two sets of blades which are of opposite curvature. When running in one direction the steam passes over the blades at the outer circumference from left to right; when running in the opposite direction steam passes over the other set of blades from right to left. In either case the loss of energy due to the blowing action of the second set of blades only amounts to a small fraction of the total, and the experiments show it to be 2 to 3 per cent. It is reported that this engine starts well under load both on curves and gradients, and that the consumption of steam has not exceeded 38 lbs. per horsepower hour when running in either direction.

SUBJECTS AT THE GENERAL FOREMEN'S CONVENTION.—The Executive Committee of the International Railway General Foremen's Association has outlined the following subjects for discussion at next year's convention: "How Can Shop Foremen Best Promote Efficiency?" to be presented by William G. Reyer, general foreman, Nashville, Chattanooga and St. Louis, Nashville, Tenn. (this will be a continuation of the paper presented at the convention in 1910); "Shop Supervision and Local Conditions" to be presented by W. W. Scott, general foreman, Cincinnati, Hamilton and Dayton, Indianapolis, Ind.; "Shop Specialization, Work and Tools," by W. T. Gale, demonstrator, Chicago and Northwestern, Chicago; "Roundhouse Efficiency," by William Hall, shop foreman, Chicago and Northwestern, Escanaba, Mich. L. H. Bryan, Duluth and Iron Range, Two Harbors, Minn. is secretary of the association.

SANTA FE SCHOLARSHIP.—Ture Tulien, machinist apprentice at Topeka, Kans., has been awarded the Santa Fe Armour scholarship. The Santa Fe Employees Magazine maintains a scholarship at the Armour Institute of Technology in Chicago, providing for four years free tuition to the Santa Fe apprentice making the highest marks during his four years apprenticeship. At present there are two apprentices at Armour.

MOST OF THE CUBAN RAILWAYS are in the hands of British companies. The total mileage is 2,170 miles. The leading railways are: The United Railways of Havana, with 710 miles; the Cuba Railroad, with 595 miles; the Cuban Central Railway, with 262 miles, and the Western Railway of Havana with 147 miles.

AN INTERESTING MACHINE TOOL CONVERSION.

It is a well-known fact that the conversion of a practically discarded machine tool of a certain class into one capable of productive and useful work in an entirely different field is considered by machine shop foremen generally as the crowning achievement of the trade, and there are very few foremen who have not experimented along this line, although not always with entire success. Instances abound in many of the older shops where worn out planers have been metamorphisized into

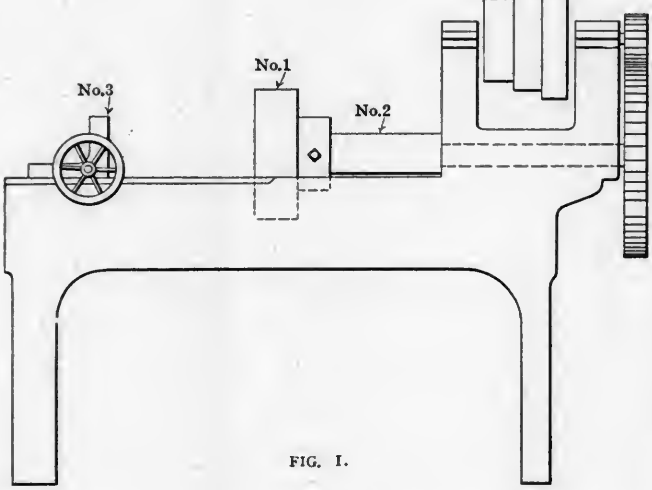


FIG. 1.

quite adequate grinding machines for the truing of guides, etc., where lathes have even been changed into drill presses and shapers made to actually bore car brasses. Whether advisable or not, these changes are always of interest as a tribute at least to the ingenuity displayed in the conception.

The conversion of an old bolt cutter, as herein illustrated, to a thoroughly efficient pipe threading machine forcibly illustrates what may be done to preserve usefulness in a tool of practically no value other than scrap. This bolt cutter was a single-head affair, of a capacity sufficient to thread bolts up to 1¼ in. diameter, and which had been crowded out of service through the introduction of modern machines. The shop in question was in need of a pipe threading machine for pipe up to 1½ in.

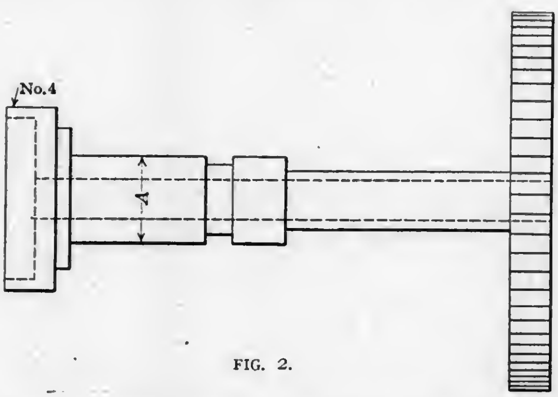


FIG. 2.

diameter, and being unable to secure the necessary appropriation for its purchase recourse was had to the old discard, and with very happy results.

Fig. 1 illustrates the assembled machine after having been changed over to include its new field of usefulness. The original die head that had been on spindle No. 2 was removed entirely, as well as the rigging which actuated its opening and closing, and the part marked No. 4 in Fig. 2 which was integral with the spindle was turned off to the size A. A new head, as shown in Fig. 3, was made from a suitable piece of cast iron. This was provided with a square countersink large enough to take in a 1½ in. pipe die, bushings, No. 5, being made for the smaller dies. Lugs, No. 6, and set screws, No. 7 serve to hold the bushings and dies firmly in place.

The vise of the carriage, No. 3, in Fig. 1 was also changed somewhat, this change being more clearly indicated in Fig. 4.

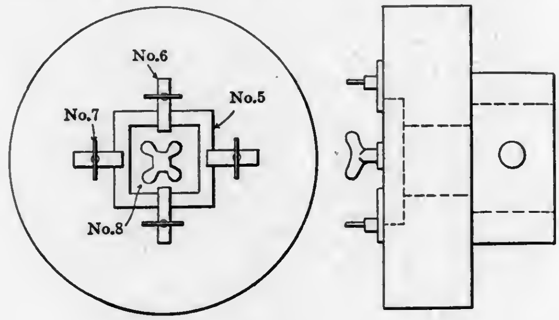


FIG. 3.

New jaws, No. 9, were made so that their shanks would fit in the original slots of the vise. These were, of course, made male and female, as shown in the above reference, this in order to clamp ¼ in. pipe as well as the 1½ in. size.

The remaining points of interest are clearly apparent in the illustrations and scarcely require further explanation, but some comment on the speed is advisable. As will be noted, the machine has a two-step cone and the pulleys were so proportioned that the spindle made 45 revolutions on the highest speed and 20 on the lowest, equivalent to a cutting speed of 12 feet per minute which left a clean-cut thread. The machine was also tried cutting thread on 1½ in. pipe on the fastest speed, that of 18 ft. per minute, but it was found that this resulted in a ragged thread. The pulleys were finally proportioned so that on the lowest cutting speed 14 ft. per minute was secured with 1½ in. pipe. The machine is in daily use in one of the large western railroad shops, and is considered to do the work with the best economy considering all factors.

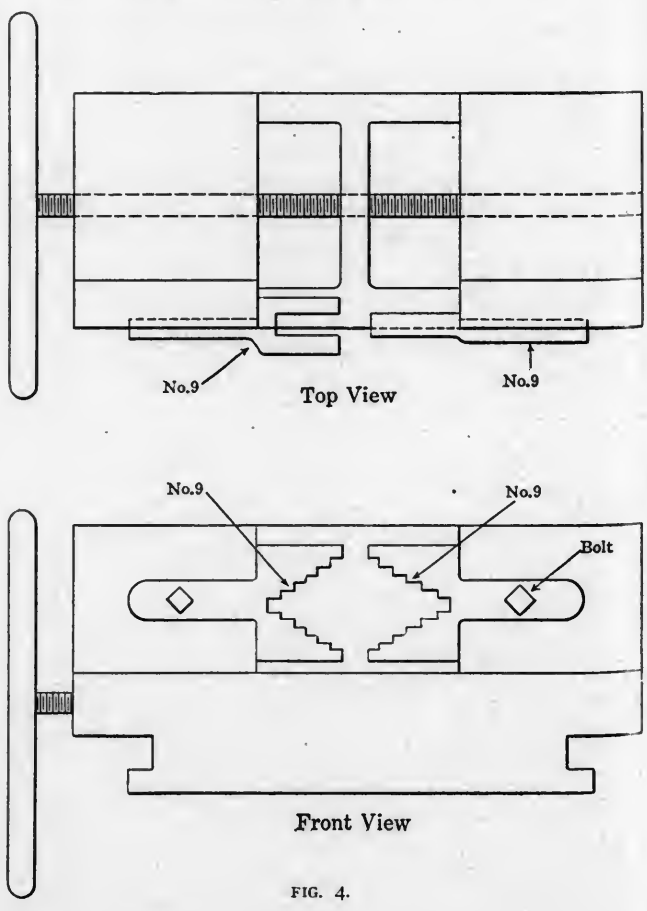


FIG. 4.

New Locomotive Terminal Facilities at Bloomington, Ill.

CHICAGO & ALTON RAILWAY.

FOR THE THIRD TIME THE CHICAGO & ALTON RAILWAY HAS FOUND IT NECESSARY TO BUILD A LARGER ROUNDHOUSE, WITH ATTENDING FACILITIES, AT BLOOMINGTON, AND ARE NOW JUST PUTTING INTO SERVICE A 44-STALL ROUNDHOUSE, WITH MODERN COALING STATION AND CINDER PITS OF SUITABLE CAPACITY WHICH WAS DESIGNED AND BUILT BY WESTINGHOUSE, CHURCH, KERR & CO.

On new ground acquired for the purpose, adjacent to the main repair shop at Bloomington, Ill., the Chicago & Alton Railway has erected a very large roundhouse. It contains 44 stalls, is 100 ft. 6 in. between circular walls, and is provided with a 100 ft. turntable, together with two cinder pits serving four tracks, each being 201 ft. 4 in. in length, and a large mechanical coaling station, spanning four tracks, having a storage capacity of 525 tons. A large sand house, sand dryer, and necessary equipment, together with two 100,000 gallon water storage tanks, have also been constructed. The steam, air, electricity and water supply are obtained from the power house of the shops, which is not far distant.

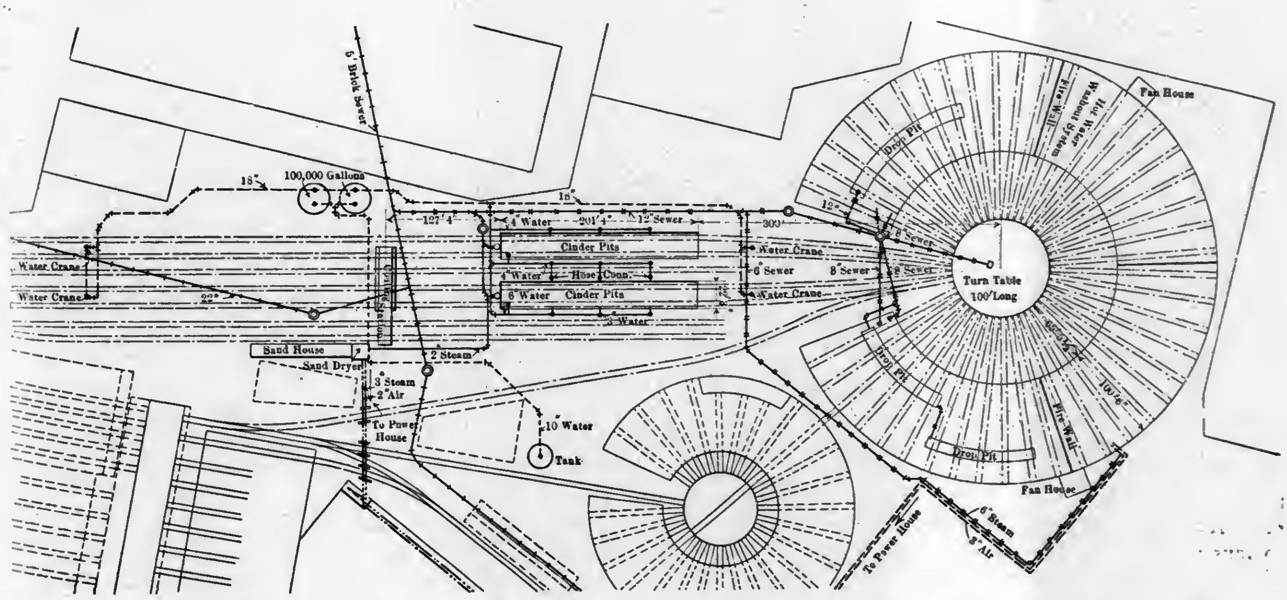
The roundhouse structure outside of its size presents very few features of interest. The decision to have a distance of over 100 ft. between circular walls is no doubt a wise one, as is also the installing of a 100 ft. power operated turntable. The practically standard dimension for roundhouses has been in the neighborhood of 90 ft., and even with the present power, particularly in drop pit sections, it is often found necessary to leave the doors open or to remove the tender and back the locomotive in for work on certain drivers. At present every indication points to continual increase in length of locomotives, and it is not beyond reason to believe that a 90 ft. house will prove to be too small for convenient work in the not distant future.

In this case the roundhouse consists of brick pilasters in the outer circle, which measure about 5 ft. in width by 17 in. thick and are supported in a concrete foundation. Between each there is a brick wall 8½ in. thick carried up 4 ft. 3 in. above the floor level, above which the space between the pilasters and to the roof, a distance of 15 ft. 7 in., is window area formed of 18 sash in 6 vertical sections, the sash being arranged to slide vertically and being counterbalanced. The roof is of the flat wooden type and rises from 20 ft. 10 in. at the outer circle wall to 25 ft. 1¾ in. at the inner circle. It is covered with four-ply tar and felt roofing and is supported by three 10 by 10 in. wooden posts equally spaced on the interior and a 12 by 12 in. door post at the inner wall. The doors, arranged to swing outward, are of solid wood structure and there are 5 ft. lighting transoms above them. The whole house is divided into four sections by 13 in. fire walls giving ten pits in two sections and 12 in the other two. The tracks are at an angle of 7° 12' and reach the turntable circle without the use of frogs.

Concrete has, of course, been liberally used throughout the structure, the floors, pits and foundations being of this material, as well as the turntable circle wall and foundation. The engine pits are shown in detail in the illustrations and will be seen to be particularly well designed. They are 77 ft. in length, there being a drop of 6 in. toward the inner circle for drainage, the maximum depth of pit being 3 ft. The side walls are made 2 ft. 4 in. in thickness, which gives a solid support for jacks on either side of the locomotive for the full length. A novelty is introduced at the outer end of the pits, where there is a depression in the concrete outside of each track rail 16 in. wide and 11 in. deep covered with a removable section of wooden flooring. This depression is 11 ft. in length and is provided for the convenient insertion of jacks under the bumper beams of low wheeled locomotives.

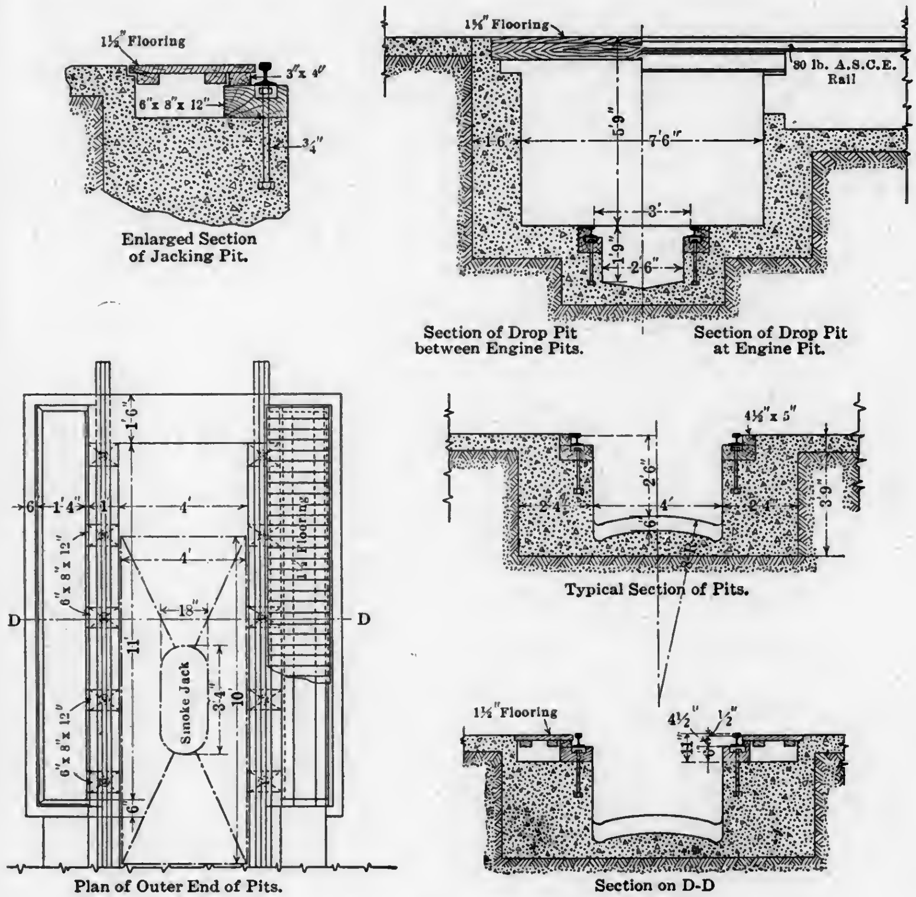
An unusually liberal provision for drop pits has been made in this roundhouse, there being 12 pits served with driver drop pits and five other pits having a truck drop pit.

Over each alternate pit, located at about the center, there is a



PLAN SHOWING RELATIVE LOCATION OF NEW ROUNDHOUSE AND ACCOMPANYING IMPROVEMENTS AT BLOOMINGTON, ILL.

36 by 24 in. cast iron roof ventilator, which is practically the only means of escape for the steam and gas, which always collects and hangs along the roof of a roundhouse. There is no opening around the smoke jacks or under the roof at the inner end, which is the highest point of the structure. The smoke jacks are of asbestos moulded to form and bolted together, the are of the customary concrete design under the floor, having branches running to each pit. There are also branches leading to outlets under the windows in the outer wall, discharging at a point 3 ft. 6 in. above the floor. The largest of the main heating ducts has a section of 47 by 60 in. at the fan and gradually reduces in size into 22 by 24 in. at the last stall, each duct serving

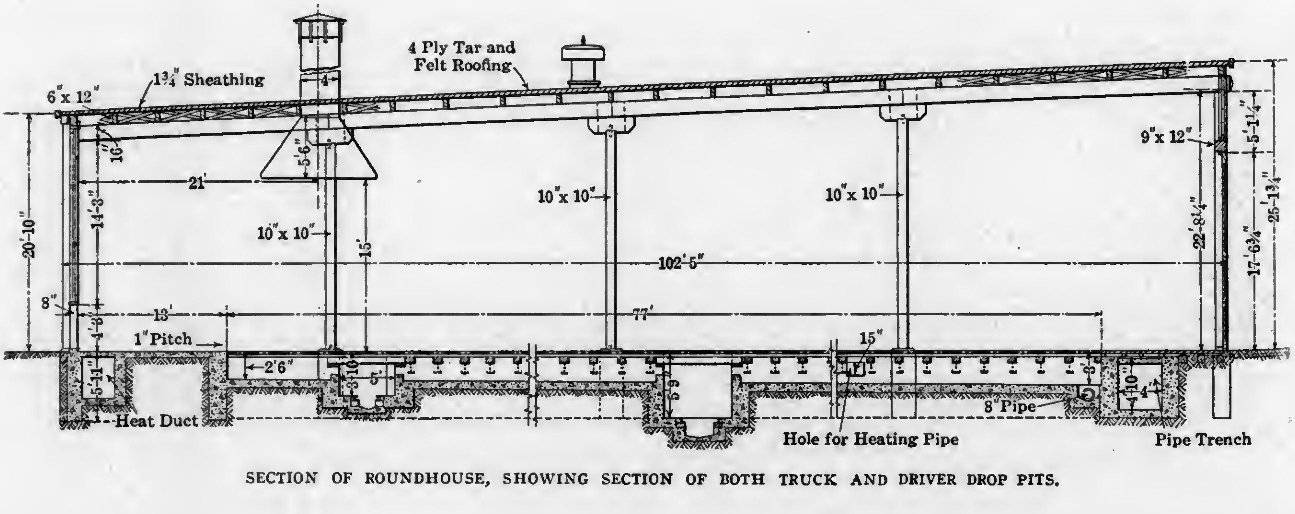


DETAILS OF PITS, SHOWING JACKING PIT AT OUTER END.

bottom of the hoods being 4 ft. in width and 10 ft. in length. They are carried to a good height above the roof, there being none of the straight section of the jack inside the house.

The heating is provided by the indirect system, using hot air supplied by two 180 in. engine driven fans, capable of completely renewing the air in the building in 18 minutes. These two fans are located in separate fan houses about 24 ft. square, built as small additions to the roundhouse. The heating ducts 15 stalls. Heat is supplied entirely by live steam from the power house, there being a 6 in. main carried to the roundhouse for running the fan engine, the pumps, steam blowers and for the steam heating coils.

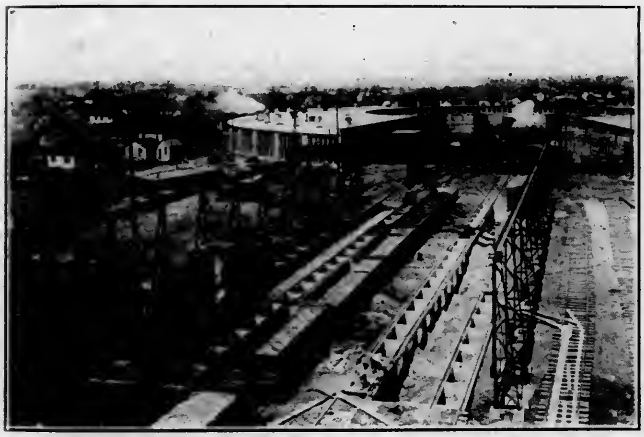
One of the pits has been omitted and this space is occupied by the hot water boiler washing and filling system supplied by the National Boiler Washing Company of Chicago. (For full illustrated description of this apparatus see American Engineer,



SECTION OF ROUNDHOUSE, SHOWING SECTION OF BOTH TRUCK AND DRIVER DROP PITS.

VIEW IN CIRCLE OF BLOOMINGTON ROUNDHOUSE.

Dec., 1910, page 469.) All piping from the boiler washing system, as well as the water, compressed air, etc., with the exception of the blowing off pipe, which is carried overhead, are installed in the pipe trench of concrete running around the circle at the inner ends of the pits. There is a separate fire line, connected to the city water system, having sixteen two-inch plugs distributed throughout the roundhouse and vicinity. Artificial illumination is provided by 250-watt tungsten lamps, two of which are suspended from the roof over the spaces between stalls. For lighting the turntable and tracks outside there are four flaming arc lamps mounted on wall bracket fixtures on the inner circle of the house.



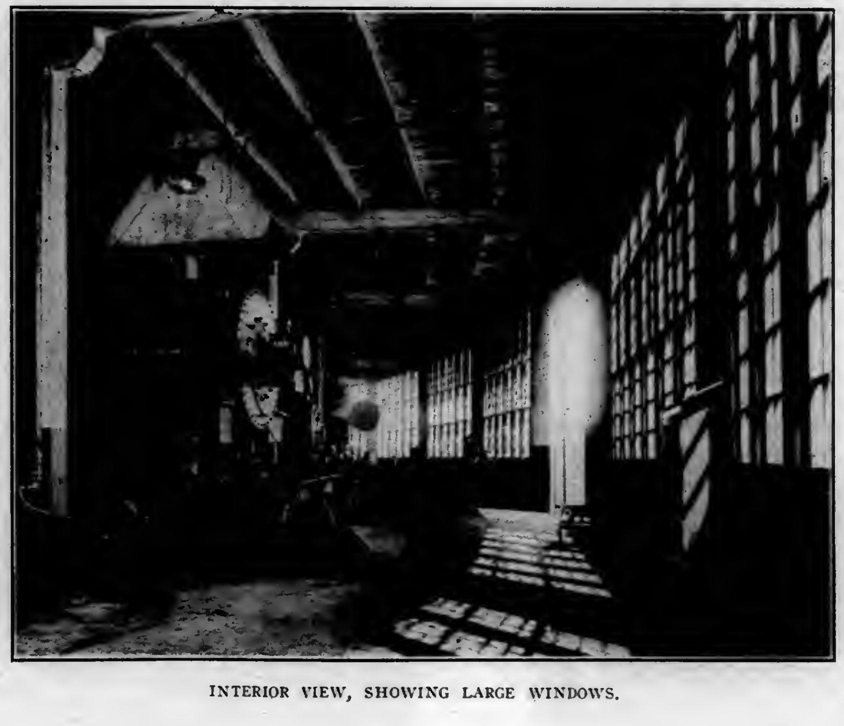
BIRD'S-EYE VIEW OF MECHANICAL CINDER PIT.

On the 100 ft. deck type turntable there is provided an electric turntable tractor furnished by George P. Nichols and Brother, which utilizes a 20 h.p. d.c. motor of the crane type. This apparatus also includes an electrically driven winch for handling dead locomotives.

On each of the four tracks leading to the roundhouse are provided cinder pits of large size, arrangement being made for mechanically handling the cinders. These four tracks are in pairs, between which there is a track located on the same level for cinder cars. Each pair of tracks are really served by one pit, the arrangement being such that the concrete bottom of the pits underneath the tracks slopes inward to a large open concrete pit between the tracks, the cinders being discharged entirely by gravity into this open space. The outer rail of each track is carried on the concrete retaining wall of the pits and the inner rail is supported on 18 in. I-beam stringers encased in concrete and resting on concrete piers 10 ft. apart, there being a reinforcing wall from each pier to the side of the pit; cutting up the length into 10 ft. compartments. Spanning both of the double pits and covering their full length there is a traveling crane, which operates a grab bucket and loads the cinders into the cars on the center track. This crane is of the four-motor type, operated from a cab carried on the trolley. The cinder pits are usually kept filled with water to a depth of 4 or 5 ft.

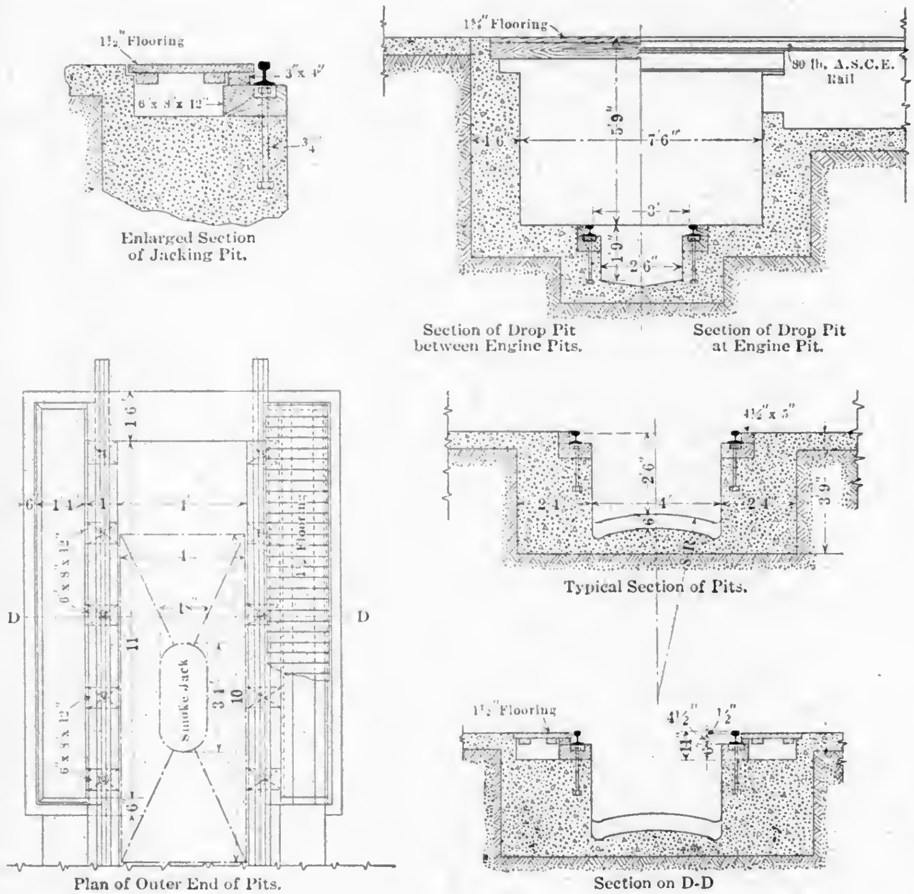
It will be readily apparent that this same cinder handling apparatus can be used in case of an emergency for coaling locomotives by simply putting the loaded coal cars on the cinder car track and using the grab bucket and crane to load the tenders. One of the illustrations shows the construction at this point very clearly.

A supply of coal can be obtained on any one of the four tracks that lead over the cinder pits, the station being of the elevated bunker type provided with crushers and bucket conveyors. The structure is of steel and reinforced concrete, entirely fireproof, and provided with coal handling apparatus in duplicate. There are two receiving tracks passing over a concrete pit about 35 ft. in length, in which are located two hoppers and crushers. Each crusher can discharge into



INTERIOR VIEW, SHOWING LARGE WINDOWS.

36 by 24 in. cast iron roof ventilator, which is practically the only means of escape for the steam and gas, which always collects and hangs along the roof of a roundhouse. There is no opening around the smoke jacks or under the roof at the inner end, which is the highest point of the structure. The smoke jacks are of asbestos moulded to form and bolted together, the are of the customary concrete design under the floor, having branches running to each pit. There are also branches leading to outlets under the windows in the outer wall, discharging a point 3 ft. 6 in. above the floor. The largest of the main heating ducts has a section of 47 by 60 in. at the fan and gradually reduces in size into 22 by 24 in. at the last stall, each duct serving



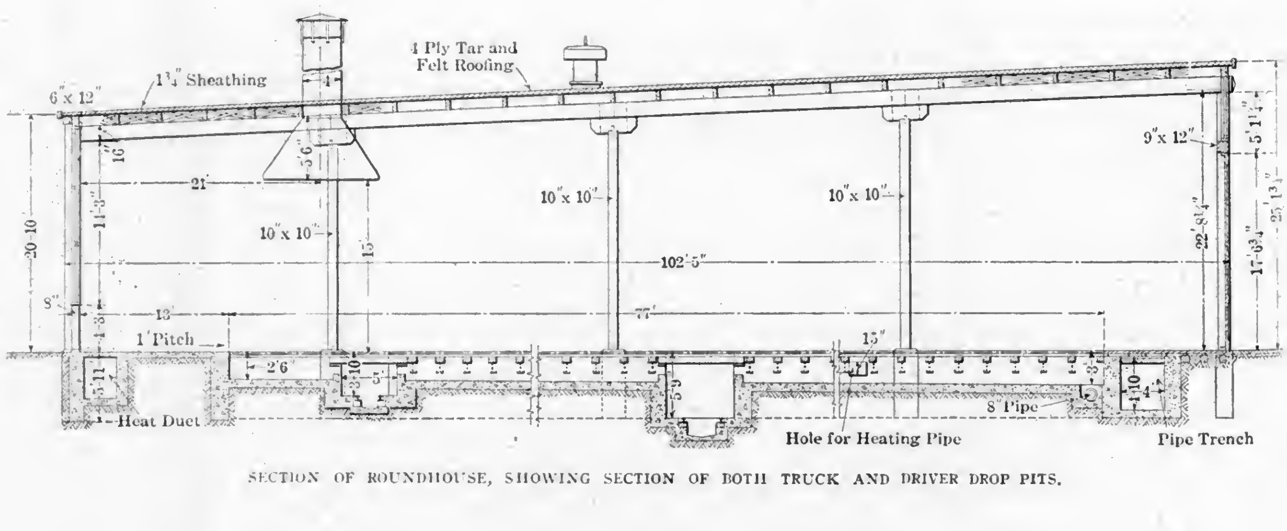
DETAILS OF PITS, SHOWING JACKING PIT AT OUTER END.

bottom of the hoods being 4 ft. in width and 10 ft. in length. They are carried to a good height above the roof, there being none of the straight section of the jack inside the house.

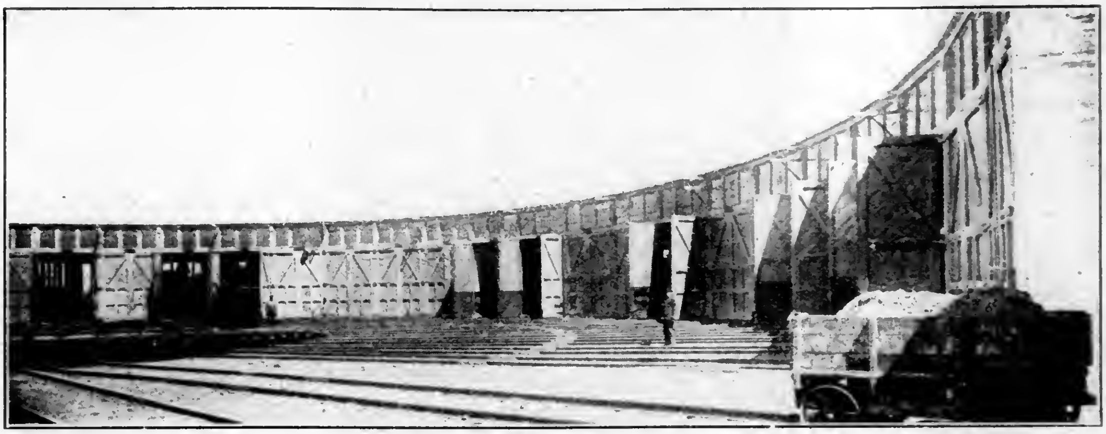
The heating is provided by the indirect system, using hot air supplied by two 180 in. engine driven fans, capable of completely renewing the air in the building in 18 minutes. These two fans are located in separate fan houses about 24 ft. square, built as small additions to the roundhouse. The heating ducts

15 stalls. Heat is supplied entirely by live steam from the power house, there being a 6 in. main carried to the roundhouse for running the fan engine, the pumps, steam blowers and for the steam heating coils.

One of the pits has been omitted and this space is occupied by the hot water boiler washing and filling system supplied by the National Boiler Washing Company of Chicago. (For full illustrated description of this apparatus see AMERICAN ENGINEER,

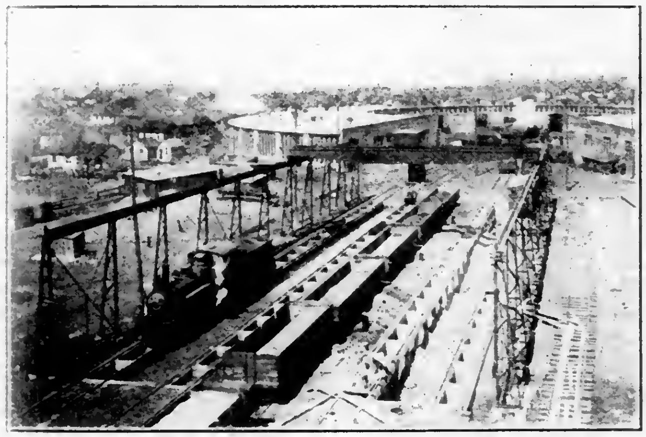


SECTION OF ROUNDHOUSE, SHOWING SECTION OF BOTH TRUCK AND DRIVER DROP PITS.



VIEW IN CIRCLE OF BLOOMINGTON ROUNDHOUSE.

.., 1910, page 469.) All piping from the boiler washing sys- m, as well as the water, compressed air, etc., with the excep- n of the blowing off pipe, which is carried overhead, are in- alled in the pipe trench of concrete running around the circle the inner ends of the pits. There is a separate fire line, con-



BIRD'S-EYE VIEW OF MECHANICAL CINDER PIT.

ected to the city water system, having six- een two-inch plugs distributed throughout he roundhouse and vicinity. Artificial illu- nation is provided by 250-watt tungsten mps, two of which are suspended from the of over the spaces between stalls. For ghting the turntable and tracks outside there re four flaming arc lamps mounted on wall racket fixtures on the inner circle of the house.

On the 100 ft. deck type turntable there is rovided an electric turntable tractor fur- shed by George P. Nichols and Brother, which utilizes a 20 h.p. d.c. motor of the rane type. This apparatus also includes an lectrically driven winch for handling dead comotives.

On each of the four tracks leading to the undhouse are provided cinder pits of large ze, arrangement being made for mechanically andling the cinders. These four tracks are n pairs, between which there is a track lo- ated on the same level for cinder cars. Each pair of tracks are really served by one pit, the arrangement being such that the concrete ottom of the pits underneath the tracks slopes nward to a large open concrete pit between the tracks, the cinders being discharged en- tirely by gravity into this open space. The outer rail of each track is carried on the concrete retaining wall of the pits and the inner rail is supported on 18 in. I-beam stringers encased in concrete and resting on concrete piers 10 ft. apart, there being a reinforcing wall from each pier to the side of the pit, cutting up the length into 10 ft. compartments. Spanning both of the double pits and covering their full length there is a traveling crane, which operates a grab bucket and loads the cinders into the cars on the center track. This crane is of the four-motor type, operated from a cab carried on the trolley. The cinder pits are usually kept filled with water to a depth of 4 or 5 ft.

It will be readily apparent that this same cinder handling apparatus can be used in case of an emergency for coaling locomotives by simply putting the loaded coal cars on the cinder car track and using the grab bucket and crane to load the tenders. One of the illustrations shows the construction at this point very clearly.

A supply of coal can be obtained on any one of the four tracks that lead over the cinder pits, the station being of the elevated bunker type provided with crushers and bucket conveyors. The structure is of steel and reinforced concrete, entirely fireproof, and provided with coal handling apparatus in duplicate. There are two receiving tracks passing over a concrete pit about 35 ft. in length, in which are located two hoppers and crushers. Each crusher can discharge into

INTERIOR VIEW, SHOWING LARGE WINDOWS.

either of the two independent bucket elevators, each with a capacity of 80 tons per hour, and driven by a 15 h.p. motor. The crushers are operated by 25 h.p. motors. The coal handling part of the station was furnished by the Exter Machine Works.

In the coaling station is also provided a storage bin for dry sand, a supply of 7½ cu. yds. being stored for each of the four tracks. The sand is dried by steam dryers in a separate structure, and elevated by air pressure to the storage bin.

The general water service for the whole terminal is taken from the regular supply system at the shops, there being two new 100,000 gallon wooden storage tanks provided near the coaling station. These are located on a steel structure 20 ft. in height and from them water is distributed through 18 in. mains to the four 12 in. water cranes. A supply is also carried into the roundhouse for general service purposes.

In addition to the six inch line for the fans and general steam service there is a 3 in. line of steam piping carried to the sand dryer, an extension of which passes to the cinder pits for the purpose of thawing out engines in winter time. This line comprises about 1,000 ft. of underground pipe. Unusual precautions have been taken for protecting and draining this and the other steam lines, all of which are underground.

The whole terminal was designed and erected by Westinghouse, Church, Kerr & Co., New York.

Traveling Engineers Association, Nineteenth Annual Convention

A REVIEW OF THE VARIOUS COMMITTEE REPORTS AND THE DISCUSSION THEREON PRESENTED AT THE CONVENTION HELD IN CHICAGO, AUGUST 29—SEPTEMBER 1.

The nineteenth annual convention of the Traveling Engineers Association was held at the Hotel Sherman, Chicago, August 29 to September 1. F. C. Thayer, of the Southern Ry., Atlanta, Ga., presided, and in his address briefly reviewed the work of the association and called attention to the opportunities that are now presented the traveling engineers as individuals and as an organization for further effective work in promoting efficiency and economy. Mr. Thayer also directed attention to the importance of the traveling engineer in introducing proper tonnage ratings and securing proper locomotive maintenance. On the opening day Robert Quayle, general superintendent of motive power, Chicago and North Western Ry., in an excellent address made a strong personal appeal for absolute and fearless honesty on the part of the traveling engineers in the performance of their duties. In this latter connection Mr. Quayle said in part:

"The traveling engineer's duties are twofold—he must stand for the men, and he must stand for the company. Get the men with you and stand with them. They will pull for you, and thus for the company which you represent. Be honest! If you believe an engineman is not doing his best, ask him what is wrong with his fireman, and if he replies, 'Nothing,' ask him about his engine. He cannot blame it on the engine if you are on it and can see for yourself that it is all right. Then you can put it up to him. Tell him you can afford to give him $1,000 or $1,200 a year to stay at home and put some one else in his place. It will touch his pride, for he will not want to be classed below the average. It will make him think, and there will soon be something doing, for the truth pinches and squeezes hard.

"The traveling engineer should keep things stirred up, not alone with the enginemen, as suggested above, but with the roundhouse foreman, the master mechanic and the superintendent of motive power. If the roundhouse foreman allows work reported by the engineer to go out unattended to, it will make the engineer careless in reporting work. Ask the foreman why it was not attended to, and if he pleads the lack of help, ask him why he did not get more. Keep after and pound the master mechanic and superintendent of motive power for the assistance or co-operation which they should give. Do not report favorably on a device because your superiors are interested in it, financially or otherwise. They want to know the truth about it."

The number of carefully chosen and well presented committee reports forcibly attest to the value of the work being performed by this important association. The questions of fuel economy, efficient handling of the electric locomotive, developments and improvements in automatic stokers, Mallet compound engines in road service, lubrication of locomotives using superheater steam, and the benefits derived from the use of the brick arch were each ably presented and practically every paper was accorded an animated and valuable discussion. The practical nature of these subjects carries a particular appeal at this time, and it is very sure that much valuable data has been tabulated and a much better understanding of the various problems exists than prior to this convention.

The report of the secretary, W. O. Thompson, showed a membership of 812, an increase of 5.4 per cent. during the past year. He has a balance of $384 on hand, with no liabilities, and a considerable amount still due for membership dues, advertising and for examination books. The report of the treasurer, C. B. Conger, showed a balance on hand of $1,328.

PROPER INSTRUCTION ON FUEL ECONOMY

V. C. Randolph, supervisor of locomotive operation of the Erie Railroad, presented a valuable and timely paper on the subject, of which the following is an abstract:

It is not the intention to theorize as to what might or could be done, but to narrate what has been accomplished in actual practice on a railway, where on several divisions supervisors of locomotive operation were appointed who have charge of all locomotives in service, for the purpose of improving economies in the use of fuel, lubricating material, tools and other supplies. In the beginning it was thought advisable to first try it out on one division.

The accompanying chart shows graphically the saving that was made on freight and passenger locomotives of the Allegheny division during 1910 as compared to 1909; also the record for the first three months of 1911. The curves for the passenger locomotives are based on the pounds of coal used per locomotive mile, while those for freight service are on the basis of coal used per 1,000 ton miles. It will be noted that the savings during the first three months of 1911 were nearly as great as for the whole of 1910.

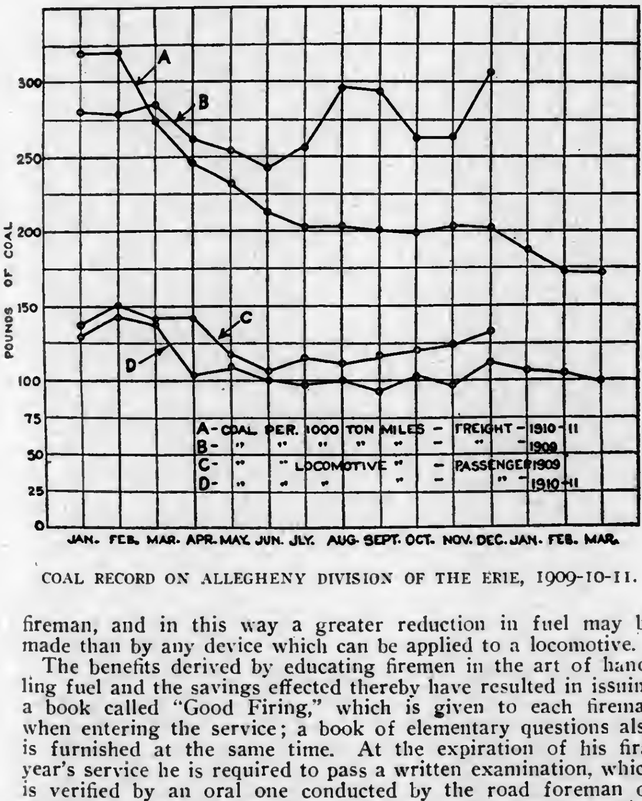
Mr. Randolph, through the presentation of tables, pointed to the saving which has been effected. It was shown that for the first three months of 1911, as compared with the same period of 1910, the total saving was $28,605.83. Another table illustrated that the total net saving—all classes of service—1910 as compared to 1909, amounted to $30,020.84. In these tables there was a slight apparent discrepancy between tons of fuel saved and its money value, but this is due to the fact that the price per ton was not uniform over the entire period under consideration.

The author of the paper described in some detail the various points of omission or commission which have a bearing on fuel economy. Many of these of course are elementary, and need not be repeated, but the value of the paper was not impaired by alluding to them. It was pointed out that personal supervision of the work of firemen has an important bearing on the general results, and that co-operation between the engineer, fireman and supervisor is no mean factor towards the end desired. In conclusion Mr. Randolph said:

The cleaning and keeping of fires at terminals is a very important question. A great saving in coal can be effected in cleaning fires by leaving them in proper condition and plenty of water in the boiler when they arrive on the ash-pit. This requires the co-operation of the engine crews and hostlers. The fire should be burned comparatively low, especially at the back end of the firebox, as about the first thing the cleaner does is to drop the

back dump grate. As a protection to the flues the fireman or hostler should, before leaving the engine on the arriving track, throw a few shovelfuls of coal into the forward end of the firebox. In cleaning the fire, any unburned coal or live fire in the back end should be pushed ahead, the back section of grates shaken, then the dump grate dropped (when the dump is next to door sheet), and any clinkers broken up and disposed of. The forward section of the grates should then be shaken and any clinkers pulled back and forced through the dump. After this operation the grates should be leveled and the dump grate closed. If the engine is to lay over several hours, the fire should be pushed ahead, leaving the dump and one or two grates bare, then covered over as the condition of the fire warrants, in all cases sufficiently to prevent the pops opening. When the engine is ordered, the fire should not be broken up until shortly before leaving time, unless necessary on account of poor fire. The excessive use of the blower should be guarded against at all times and especially when cleaning the fire. The roundhouse foreman and staff should understand the importance of keeping the draft appliances, grates and flues in proper condition.

The condition of the locomotives is the governing factor in effecting fuel economy, and it would be poor policy to neglect repairs that would cost a few dollars and by so doing consume perhaps a hundred dollars' worth of coal per month or even more. The location of the steam gage should be given more attention, particularly on the large locomotives, as close firing requires close observation of the pressure. If a swing door, the latch should hold it positively open when putting in coal; when practical, a small chain should be provided, hung from some convenient point and only slack enough to allow it to drop into place. The deck sheet should be closely fitted, leaving no holes for coal to drop through. By looking after these apparently small points it helps to get and keep the co-operation of the engineer and



COAL RECORD ON ALLEGHENY DIVISION OF THE ERIE, 1909-10-11.

fireman, and in this way a greater reduction in fuel may be made than by any device which can be applied to a locomotive.

The benefits derived by educating firemen in the art of handling fuel and the savings effected thereby have resulted in issuing a book called "Good Firing," which is given to each fireman when entering the service; a book of elementary questions also is furnished at the same time. At the expiration of his first year's service he is required to pass a written examination, which is verified by an oral one conducted by the road foreman of engines or other persons appointed by the proper authority, necessary knowledge being obtained from the book furnished, attendance at instruction classes held by the road foreman or supervisor of locomotive operation; also from information received and instructions given him by either, when on the engine or otherwise.

At the end of the first year and after passing the examination, the first year's question book is returned and the list of questions on the second series is given him. At the expiration of the second year, another examination follows, which is progressive in form, it being a little harder to obtain the answers. The third year's series consists of his final mechanical examination, which, if satisfactorly passed, qualfies him as a locomotive engineer.

To create interest in a competitive way among all engineers, an individual performance sheet is issued monthly on each division, which shows the name of each engineer, the number of his engine (when regularly assigned), the engine mileage made by each engineer, the amount of lubricating material used and cost per 1,000 locomotive miles, also the miles made per pint of oil. It also shows the number tons of coal used and cost per 1,000 ton miles in freight service, and the number tons of coal used and cost per 1,000 locomotive miles in freight, switching and passenger service, respectively. In freight service the total ton-miles moved are also shown. The cost of tools and other supplies is shown on the 1,000 locomotive mile basis for all classes of service. A percentage column relates entirely to each of the three sub-divisions, the percentage being based on the lowest performance, i. e., the lowest in cost will be classed as 100 per cent., all others being of a corresponding ratio. While costing considerable time and money to prepare a report of this kind, it has proved itself to be a good investment to the company, for as a rule each engineer and fireman takes pride in trying to reach the 100 per cent. mark.

Discussion: The general interest in this subject naturally resulted in a thorough discussion which developed many features of value. One significant point brought out was that the enginemen cannot be expected to make great efforts to save fuel by the scoopfull if they see it wasted in innumerable ways before it gets on the tender, therefore the importance of fuel saving should be appreciated by the entire organization from the top down.

On the high capacity locomotives where the fireman is forced to work near his limit, the problem of closing the fire door after each shovelfull becomes a serious one. Several of the members spoke very favorably of the use of automatic fire doors under these circumstances. An instance was also cited where the heat prostrations during the summer months were greatly reduced, due to the application of such doors. The company should do its part in making the work of the men easier. Undoubtedly the engineer would just as soon hook the lever up a little higher, if he was sure that it would not interfere with the lubrication of the valves and cylinders, and if the lever could be easily handled, so as not to threaten to jerk him off the seat box.

One speaker said that the first place to begin fuel economy was in improving the condition of the engines. He also experiences a great deal of trouble in securing firemen and believes that the only solution of the problem is in the introduction of mechanical stokers. The best results in obtaining fuel economy are only possible with the hearty co-operation of the higher officials; the road foreman must have their backing to enforce his orders.

Mr. Randolph said in reply to a question that in riding the engines he checked the work of the fireman carefully. By means of a counter in his pocket he kept track of the number of shovelsfull fired. Of course the different firemen vary as to the amount they carry on the shovel, but by watching closely this could be estimated with a fair degree of accuracy. The figures at the end of the run were checked against the amount of coal remaining on the tender. In this way it is possible to get a good line on the men, especially when a number of records have been taken for different men on the same run and under similar conditions.

Where a man's record is poor, as shown by the monthly performance sheets, the matter is taken up with him privately; letters are used only under extreme conditions. The transportation department has assisted in the work where matters have been called to its attention which could easily be remedied. On the Allegheny division of the road the coaling stations are such that a fairly accurate estimate of the coal given to each engine is possible.

MALLET COMPOUNDS IN ROAD SERVICE

J. B. Daugherty (B. & O.) presented a very complete paper on this timely subject, one which probably may be regarded as one of the most important of those read before the convention. Locomotives of this type have been considered by many as best adapted for pusher service, therefore this data illustrating their usefulness in actual road work is of considerable value. The salient points of the paper are as follows:

The Baltimore & Ohio Mallet locomotive No. 2400 was put into regular helper service on the Connellsville division. From January 6, 1905, to and including September, 1909, the locomo-

tive made 113,956 miles, the major portion of which was in helping service between Rockwood and Sand Patch. During this period it received classified repairs as follows: Class 4, F. T., Connellsville, February 15, 1906; class 3, Connellsville, June 7, 1907; class 4, F. T., Connellsville, June 11, 1908. Shortly after September 30, 1909, it was shopped at the Riverside shop for class 3 repairs. During the period referred to above the locomotive was available for transportation use 33,499 hours, and unavailable 6,405 hours, or it was available for transportation use 84 per cent. of the time. The cost per 100 miles run for repairs, including running and classified, averaged $9.04. The cost of operating this locomotive from the time it was put into service up to and including September 30, 1909, including repairs, fuel, supplies and in fact every item of expense entering into the operation and maintenance of the locomotive per 100 miles run, amounted to $46.96, based on the actual mileage made by the locomotive during this period.

On February 20, 1906, it was used in road service with a view of making a test against two Class E-27 locomotives, with the same tonnage as handled by locomotive 2400. The results of the test were as follows:

	Two E-27	No. 2400
Number of cars	38	35
Tons	2,473	2,435
Actual running time	2 hrs. 45 min.	3 hrs. 43 min.
Coal consumed	30,000 lbs.	20,000 lbs.
Pounds of coal per locomotive mile	698	465
Pounds of coal per car mile	18,334	13,280
Pounds of coal per ton mile	.282	.191
Water consumed	19,200	15,700
Water evaporated per pound of coal	8 lbs.	6.05 lbs.

Locomotive 2400 used 25 per cent. more coal than one of the Class E-27 locomotives and 33⅓ per cent. less fuel than two E-27 locomotives. The lubrication of the Mallet locomotive compared with other locomotives in the same service for twelve hours was: locomotive 2400, three pints valve oil, five pints car oil, one-half cup grease; cost, 32 cents; two E-27 locomotives, three pints valve oil, three pints car oil, one-fourth cup grease; cost, 27 cents.

We have experienced no trouble keeping firemen on locomotive 2400, as they are paid 25 cents per day more on this engine than on consolidation engines in the same service. Locomotive 2400 decreases rail and tie strain since it has but 11 ft. rigid wheel base, and can be handled over track where the heavy consolidation locomotives cannot be used. We have experienced no difficulty in keeping the flexible joints tight in the low pressure steam and exhaust pipe joints.

The consumption of fuel by the Mallet compound locomotive equipped with a superheater on the Chesapeake and Ohio Ry. is about one ton of coal less per trip than for an ordinary consolidation locomotive. The Mallet locomotive not equipped with a superheater consumed about one ton of fuel more than the consolidation locomotive. The average cost of lubrication on the Mallet, as compared with all other classes of locomotives, is about 50 per cent. greater on account of the large wearing surfaces. The average speed of the Mallet is about the same as that of consolidation locomotives; they are able to attain a speed of forty-five miles per hour. Firemen consider it less exertion to fire a Mallet locomotive than other classes of locomotives. Judging by the work that has been performed by Mallet locomotive 751, it will make the same mileage and handle 50 per cent. more tonnage than the consolidation locomotive between classified repairs.

Tests were made on the Great Northern, where Mallet locomotives are in regular through freight service, between Minot and Williston, N. Dak. The division is 122 miles between terminals. Going west from Minot there is a grade of .72 per cent. for a distance of thirteen miles, then a lighter grade of .5 per cent. for a distance of eight miles. The road from that point for a distance of seventy-five miles is what might be termed a rolling prairie with gradual ascending and descending grades; the last eighteen miles of the division have an ascending grade of .72 per cent. into Williston. The Mallets have 20 in. & 31 in. x 30 in. cylinders, 55 in. driving wheels, carry 210 lbs. steam pressure and are of the 2-6-6-2 type. During the summer months these locomotives are rated at 2,200 tons over this division.

The heaviest tonnage handled by the Mallet locomotive during the time of these tests was 1,615 tons in forty-four cars. With this tonnage it consumed one hour and thirty minutes in covering the first thirteen miles of .72 per cent. grade. From that point the grade is somewhat lighter, and the train arrived at Berthold, twenty-two and a half miles from Minot, in two hours and twenty minutes. From this point, as previously stated, the road is a gradual rolling prairie and the next twenty-four miles were covered in one hour and thirty minutes, arriving at Williston in eleven hours and twenty minutes from the time the train departed from Minot, including delays by meeting trains and taking water and coal. The Mallet handled this tonnage over heavy grades with considerable less shock to draft rigging than the consolidation locomotive, because both units of the Mallet never slip at the same time and the slack of the train does not run up as in the case of a consolidation locomotive when slipping on a heavy grade. For this reason the Mallet is considered more reliable to handle tonnage over hard pulls than a consolidation locomotive. The speed of the Mallet will be materially reduced as soon as it strikes a slightly ascending grade, while the consolidation locomotive will go over the same grade at quite a high rate of speed. For this reason the consolidation locomotive will make considerably better time on a road which has broken grades. I am unable to give an accurate report as to the amount of coal consumed by the Mallet as compared with the consolidation, but from what I was able to observe while riding these engines I have come to the conclusion that the Mallet type will burn a little more coal per engine mile than the consolidation, but figuring on a 1,000-mile basis, the Mallet will show considerable saving. The Mallet uses about again as much lubrication as the consolidation.

Discussion: It was developed that where opposition had formerly existed to the employment of the Mallet in regular road service, it had become largely removed after personal observation of these engines under such conditions. Mr. Roesch, for instance, spent 30 days on the division of the Santa Fe where Mallet's are on through runs. He had been badly prejudiced against them, but was thoroughly converted.

In one instance he was on a Mallet pulling 60 loads with a tonnage of 2,300. It went over the division of 102 miles, and as no locomotive was available was forced to go right on over the next division of 98 miles, and then the next one of 108 miles. In all 308 miles were covered in less than 15 hours, all delays included. The average speed of these locomotives over a division with .6 per cent. grades is from 25 to 29 m. p. h., although much higher speeds are attained—as high as 45 miles per hour. Every convenience is provided for the enginemen, including air operated fire doors, bell ringers, reverse levers and cylinder cocks; also coal passers. No trouble is experienced with break-in-twos and the trains get under headway quickly.

W. F. Walsh (C. & O.) was enthusiastic over the results being obtained from the Mallets in road service. They are handling all classes of freight and are of the 2-6-6-2 type with 56-in. drivers and 22 in. & 35 in. x 32 in. cylinders. They are economical both in fuel and maintenance as compared to the consolidation locomotives. A train of 2,061 tons was hauled over a 77 mile division in 3 hr. 8 min. The first 32 miles had a rise of 22 ft. to the mile; the next 17 miles, 30 ft to the mile; the next 17 miles a down grade of 60 ft. to the mile, and the remaining 11 miles were rolling.

The consensus of opinion seemed to be that Mallet locomotives, specially designed to meet varying requirements, could be used to splendid advantage in road service. It was suggested that any new type of locomotive is expensive to maintain until the men become familiar with taking care of its various details, and that this particular objection could be very easily disposed of seemed to be in the main agreed upon by all who discussed the paper. The question as thus presented before the convention is necessarily one which must command the attention of all motive power chiefs in the very near future. If this type can operate successfully on long runs, and on such runs demonstrate the same efficiency which it has exhibited in the rather constructed field where largely heretofore employed, a great problem will have been solved. This solution largely implies the abolition of the double-header in freight service, and a greater tonnage moved at a much lower ratio of general costs. For these reasons it is believed that this particular paper is of more than passing value, not only to the convention before which it was presented, but to those who must decide in regard to the type of power to be employed for the movement of the heaviest tonnage at the minimum cost.

THE BRICK ARCH

That this is a subject of great interest cannot be denied. The proper maintenance of this appliance, in the instance of a road owning say 1,000 locomotives, means no less than $30,000 per year. This in itself may not appear as an excessive item in locomotive maintenance, provided that the item is really justified. There is, however, considerable difference of opinion about the arch. By many roads it is received as a luxury, pure and simple, because the argument cannot be denied that the locomotive's steam as well without as they do with it. In the abstract, how-

ever, many other reasons may be advanced for its use, which were set forth by the committee, Messrs. Tawse, Cooper, Butler, Wright and Randolph, in part as follows:

The design and construction of the brick arch to-day is the result of several years of close study, painstaking investigations and experiments by men of large experience in locomotive operation, resulting in eliminating the objections that have heretofore existed against the brick arch. The most noticeable improvement in brick arch construction is the sectional arch, the brick being made of small units, so that certain sections can be removed for flue work and staybolt inspection, without interfering with the other portions of the arch, resulting in the saving of the arch and of time due to installing a new arch.

Other things being equal, the brick arch adds to the boiler capacity by making each square foot of heating surface count for more steam. This because of the fact that the firebox temperatures are always found to be increased by the installation of the brick arch. The brick arch adds to the firebox capacity and the fireman's capacity, because the more complete combustion forces each pound of coal to yield a higher percentage of its total heat units. It saves coal because of the better combustion and because of the baffling and retaining effect on the gases and on the fine and light combustible matter, which otherwise would be drawn through the flues in the form of sparks or partly consumed coal.

The brick arch abates the smoke and cinder nuisance by more thorough combustion, due (1) to the better mixing effect of the gases and oxygen of the air drawn into the furnace chamber, and (2) that the longer flame travel gives more time for combustion to be completed before the gases pass into the tubes and are lost. The baffling effect on the cinders is a thing that can be determined, and numerous tests carefully conducted show a very marked decrease in cinder throwing due to it.

The brick arch affords a protection to the flues. This statement can be verified by inquiring of almost any one responsible for the up-keep of flues who has had opportunity to observe the difference in this respect between arch engines and no-arch engines. The result is due, no doubt, to the fact that wide and sudden variations in flue temperatures are prevented by the presence of the arch.

The reasons for a growing demand for brick arches are many, the principal ones being:

1. The growing demand for boiler capacity and fuel economy. This was met in years gone by with larger designs. There was plenty of room for growth in size and weight of boiler and plenty of margin in fireman capacity or endurance. Not so now. These limits are reached, hence the requirements such as brick arches, superheaters and other devices to further extend the capacity of the boiler.

2. The growing public sentiment and demand for economy in railway operation. The consumers of transportation are putting forth arguments for properly enforced methods of economy, hence any accessory that will yield a net saving of even 5 per cent. of a railway fuel bill cannot longer be ignored. A brick arch will give a net saving of from 5 to 15 per cent., depending upon the conditions of operation.

3. The growing public sentiment against the smoke and cinder nuisance. The time is drawing near when the public will demand either the suppression of the smoke and cinder nuisance, or the suppression of the steam locomotives. The arch is recognized as one of the best smoke preventers and as one of the most efficient devices for reducing the quantity of sparks thrown from the stack, and on this account it becomes directly valuable as a fuel saver.

From the replies received it is quite evident that the nozzle tips can be opened up with the application of the brick arch. This is accounted for by a greater percentage of the gases from the coal being consumed; as the function of the brick arch is that of a mixer it brings about a more complete mingling of the gases, thereby aiding combustion, resulting in higher temperatures in the firebox. These claims have been fully sustained by many experiments made on different roads. Many of the replies are very flattering on the benefits derived from the use of the brick arch where water conditions are considered bad, the steam failures having been reduced from 50 to 75 per cent. Instances have been cited where locomotives arrived at terminals with flues leaking each trip without the arch (all are familiar with the excessive loss of fuel with leaking flues) and since the arch has been applied the same locomotives are now making several trips before flues need attention. These favorable results are due to the uniform degree of heat maintained in the firbox, and elimination of the cold air passing through the firebox door, being deflected by striking the arch before reaching the flues.

We do believe that theoretically there should be no opening next to the flue sheet and that all the gases should be made to pass over the rear of the arch. In actual practice, however, there are localities in which conditions are such as to require clearance at the front, and our only recommendation in this regard would be to experiment with the arch tight to the flue sheet, bringing the drafting of the smoke box to favor it as much as possible, and if, after a thorough trial has been made, success is not met with, use a small spacer block on the tubes. A compromise may be effected by having the middle section tight to the sheet to protect the lower central flues, and the side courses set back to give clearance through which accumulations may be discharged to the grate. This is a question which will no doubt bring out some good discussion on the results of the location of the arch.

A test was recently made on the New York Central Lines with a wide firebox type of boiler to ascertain the efficiency of the brich arch and arch tubes. The boiler was equipped with four water bars 3 in. in diameter: 458 tubes, 15 ft. 6 in. x 2 in.; firebox length, 105 in.; width, 75¼ in.; steam pressure, 200 lbs. The evaporative power of the boiler is increased 14.9 per cent. by using the brick arch in the firebox. One-third of this increase is accredited to the water bars, while the remaining two-thirds must be due to the brick arch itself. The reason for this increase is perhaps the storage of heat in the brick arch at an advantageous place near the back flue sheet; the forcing of the path of the flame upward to the crown sheet and on through the upper flues, which are the best heating surfaces of the boiler, and keeping the flues clear of fuel. Without the brick arch, fuel is often thrown or carried by the draft into the lower flues, plugging them and thereby rendering these flues useless. It is very noticeable that there is a saving to the flues caused by the brick arch; for when the firebox doors are opened the in-rushing air must first come in contact with the hot arch and thereby become heated before reaching the flue sheet.

LUBRICATION OF LOCOMOTIVES USING SUPER-HEATED SYSTEM

The committee appointed to consider and report upon this important subject consisted of M. H. Haig (Santa Fe), chairman; W. R. Taylor (Gal. Sig. Oil), F. W. Edwards (Ohio Inj.), A. Maynes (Can. Pac.), and S. Beidelman (C. R. I. & P.). In part the paper was presented as follows:

The effect of superheat upon lubrication depends on the temperature of the superheated steam. The smoke-box type provides for superheating from 30 to 80 or 90 deg. Fahr. above the temperature of the saturated steam, while smoke-tube superheaters have in some cases produced over 300 deg. Fahr. of superheat. Conditions attending the use of low and high superheat will be considered separately.

Steam temperatures reported to the committee by the roads using smoke-box superheaters do not exceed 490 deg. Fahr. At the temperature obtained with smoke-box superheaters little trouble has been experienced from the use of the same methods of lubrication as employed on saturated steam locomotives and practically no changes have been made. Oil is being delivered to the center of the steam chest for slide valves and inside admission piston valves. Where outside admission piston valves are used the oil is introduced into the ends of the valve chamber. In some cases the cylinders have been tapped to receive direct lubrication at a point in the middle of the bore and near the top. Experience with this method, however, in some instances has led to the belief that as good results would be obtained by the usual method of feeding all the oil to the steam chest. All roads report having found it unnecessary to change the quality of oil with the application of low degree superheat. The oil in use has a flash point of about 520 deg. Fahr. There has been but little increase in oil allowance attributable to low superheat. Very little data has been received showing the effect of low degree superheat on the wear of valve and cylinder packing rings. No case has been brought to the attention of the committee where any change of material from that used with saturated steam has been found necessary. In some cases the wear appears to be a little more rapid. No change in the material of the rod packing has been made.

Eight roads have reported the use of smoke-tube superheaters, the superheat obtained varying from 100 to 200 deg. Fahr., with corresponding steam temperatures of 490 to 580 deg. Fahr. Other than increasing the quantity of oil used with either saturated or superheated steam, high boiler pressure has no effect upon lubrication.

There are several methods of introducing oil to the valves and cylinders. Two roads consider it necessary to introduce part of the oil directly into the cylinders. Others with engines so equipped have found it unnecessary to use the cylinder feed continuously, but retain it as a precaution against cutting cylinders in emergency. This is deemed desirable, as oil will reach the piston rings with less delay than when introduced through the valve chamber, especially when the engine is drifting. In providing for direct lubrication of the cylinders, it is the practice of the roads reporting to introduce oil in the middle of the piston travel and as near to the top center line of the cylinder as the construction will permit.

Satisfactory results are obtained by the use of the following methods of feeding oil to the steam chest. They all apply to inside admission piston valves. (a) Two feeds per steam chest,

one delivering oil near each admission port, preferably a little toward the center of steam chest from the ports. This is effected in two ways: by a lubricator feed for each point of delivery, or by two lubricator feeds and oil pipes branched near the steam chests. (b) The customary one feed per steam chest, introducing the oil into the center of steam chamber. (c) One feed per steam chest, introducing oil into the steam channel at a point near the steam chest. (d) Three feeds per steam chest, one in the center of the steam chamber and one at each end near the admission ports. Each point of delivery has an individual lubricator feed. The road using this method makes no provision for direct lubrication of the cylinders. The use of graphite is reported by one road. In addition to valve chamber and cylinder oil pipes, Campbell graphite cups are piped to the relief valves of a number of engines.

To insure proper lubrication at all times, it is recommended by some that steam be admitted to the cylinders when drifting. It has been found that even though proper lubrication is obtained while working steam, the valves and cylinder walls become dry after drifting for some time. A drifting valve will let sufficient steam into the valve chambers and cylinders, if properly handled by the engineer. It is reported that by proper care on the part of the engineer in always opening the drifting valve before closing the throttle it is possible to obtain a material increase in life of packing rings. One road connects the drifting valve to the superheater, passing the steam through the superheater before delivering it to the cylinders and reports very satisfactory results. Several roads have made use of mechanical feed lubricators with superheated steam, but it has not proved as satisfactory as the hydrostatic type and its use has been abandoned for the latter.

D. R. McBain, superintendent of motive power, Lake Shore & Michigan Southern, has devised and patented a means of insuring uniform delivery of oil to the steam chest of engines using superheated steam. It is used in connection with the hydrostatic lubricator. Dry steam is led from the boiler through a 1¼-in. pipe to a valve which is so arranged as to be opened by the throttle lever. When open, steam passes through two ⅜-in. copper pipes directly into the steam chest oil pipes, just ahead of the choke plugs at the lubricator end of the pipes. The steam-chest choke plugs are drilled out to the full size of the oil pipes. ⅜ in. in diameter. By this means there is a constant flow of steam through the oil pipes to the steam chest, insuring a constant and uniform delivery of the oil.

Several grades of valve oil are used on locomotives equipped with high degree superheaters. Flash points of 550 to 600 deg. Fahr. have been reported, but in most cases the same quality is provided for superheated steam locomotives that is now used with saturated steam.

High superheat has increased the quantity of oil used on valves and cylinders. The amount of this increase varies in different cases from 10 and 20 to 100 per cent. The larger percentages reported are due to the delivery of oil directly to the cylinders without a reduction in the quantity fed to the steam chest. In these cases the question of minimum oil consumption has not been extensively considered. The purpose has been to use a liberal amount of oil rather than to risk trouble from insufficient lubrication. The following statement was made by one who has had wide experience with highly superheated steam: "We are running about the same mileage on superheated steam engines as on saturated steam for valve oil, but I consider that the superheated steam engine should be given 10 to 20 per cent. more oil than the saturated.

The wear of cylinder packing rings is increased by the use of highly superheated steam. Introducing oil directly into the cylinders has not overcome this condition. The use of special material for packing rings has been attended with good results. The difference in wear of valve packing rings and valve chambers bushings is less noticeable. Piston rod packing has been very little affected by the use of superheated steam.

A few precautions should be observed in connection with the installing and operation of hydrostatic lubricators. Oil pipes from the lubricator to the valve chambers should be absolutely steam tight to insure the delivery of oil to the proper place. Care should be taken that the lubricator pipes slope toward the cylinders on an even incline throughout their entire length. To prevent the pipes being distorted they should be protected by placing them under the boiler jacket. The steam pipe from the boiler to the lubricator should be of ample size to insure full boiler pressure at the lubricator. It is desirable to start the lubricator from fifteen to twenty minutes before leaving time. It is reasonably certain where this is done that the valves and cylinders will be receiving oil when the engine is started.

All information on lubrication of locomotives received from various sources agrees so closely on the principal points, that the committee feels justified in the following conclusions:

1. The conditions affecting lubrication are practically unchanged by the degree of superheat commonly obtained from smoke-box superheaters.

2. The flash point of valve oil should be higher than the temperature to which it will be subjected at the point where lubrication is to be effected. Oils now available fulfil this condition, and if delivered to the proper surfaces will lubricate satisfactorily.

3. The hydrostatic lubricator meets the requirements of proper oil delivery. It is considered more satisfactory than the mechanical feed lubricator because of absence of moving parts to wear and get out of order.

4. The life of common gray iron packing rings is too short to commend this material for use with high degree superheat.

Discussion: There seemed to be a more or less well defined opinion in the minds of some of the speakers that entirely too much oil is being used on superheater engines. The men in charge are not yet thoroughly acquainted with the performance of these engines and are afraid to take too many chances with them. As they become more familiar with them they will find it possible to get just as good results with much less oil than many are using at present. There seemed also to be a feeling that the oil pipe direct to the cylinder could be dispensed with. The tallow pipe connected directly to the steam passage in the cylinder saddle was very favorably spoken of.

Incidents were cited where a change in the material of the cylinder packing rings produced good results. The Pittsburgh & Lake Erie has a high degree superheater with slide valves. D. J. Redding, assistant superintendent of motive power, believed that the lubrication difficulties were due to sudden shutting off the steam; he had found evidences of the oil being burnt when the engine came into the terminal station. He suggested an auxiliary steam line to the cylinders so that a small amount of steam could be introduced in the cylinders after the throttle had been closed, or else the application of larger relief valves. The discussion developed the fact that it is advisable to use a drifting valve when drifting, this valve being opened before the throttle is closed. It allows a small supply of steam to enter the cylinders through auxiliary pipes. The packing troubles can usually be traced to drifting or suddenly shutting off at high speed. Not much trouble, for instance, is experienced with low speed superheater freight engines.

It was stated that the Union Pacific had a superheater engine with slide valves, and that successful results were being gained by the use of bronze valves and valve seats. The C. & O. has 24 superheater Mallets which are used in through fast freight service. The oil is introduced directly into the steam pipe and also directly to the low pressure receiver. Schmidt superheaters are used and Galena superheater oil. The packing has not given any trouble. These engines have no drifting valves and drift down a 17 mile 1.3 per cent. grade at a speed limit of 20 miles per hour.

DEVELOPMENTS IN AUTOMATIC STOKERS

An extensive report on the subject was presented by J. R. Luckey, in which was discussed the Crawford, Hanna and Street stokers and the performance of each commented upon. It was advanced by its author that these three stokers are "making good" and he did not allude to those of other design which are in limited use. While of interest, the paper did not awaken an extensive discussion, which was probably due to the fact that the same subject was given considerable attention during the last Master Mechanics' Association Convention, and whatever new was to be said became apparent at that time. Experiments as yet are still confined to a narrow scope, but the building of a few more stokers of the same kind for each road is a healthy indication, and the extension to a wider field appears to be but a question of time.

CONVENTION BUSINESS

The committee on subjects suggested eleven subjects for 1912. These were referred to the executivee committee with the recommendation that a selection be made from them and that fewer reports be arranged for next year. In almost every case this year the discussions had to be "choked off," in order to get through the work of the convention in four days.

C. F. Richardson, the retiring president in 1910, was unable to represent the association at the Master Mechanics' convention

at Atlantic City last June, and W. C. Hayes (Erie) was delegated to do so. He presented a detailed report of the proceedings, emphasizing those features which are of special interest to the traveling engineers.

The southern members made a strong plea for the 1912 meeting. As a result Atlanta, Ga., received 71 votes, Chicago 53, and Washington, D. C., 10. There seemed to be a strong feeling on the part of many that Chicago being more central and having had the most successful meeting in the history of the association, should be again selected. The executive committee will select one of the three cities, Atlanta being given the preference if conditions will warrant.

The fiscal year will close August 1 instead of August 15. An associate member of one year's standing can make application for active membership. The president must be selected from a man in active railway service and holding the position of road foreman of engines, or a position ranking above it. The secretary can pass on the applications for associate membership.

The Traveling Engineer's Supplymen's Association elected the following officers: President, J. Will Johnson, Pyle National Headlight Company, Chicago; secretary, W. L. Allison, Franklin Railway Supply Company, Chicago; treasurer, Frank D. Fenn, Crane Company, Chicago; executive committee, W. J. Schlacks, McCord & Company, Chicago; Frank H. Clark, the Watson-Stillman Company, New York; P. H. Stack, Galena Signal Oil Company, St. Paul, Minn.

ELECTION OF OFFICERS

The following officers were elected for the ensuing year:

President, W. C. Hayes, Erie R. R.

First vice-president, W. H. Corbett, Michigan Central.

Second vice-president, F. P. Roesch, El Paso & Southwestern.

Third vice-president, John McManamy, Pere Marquette.

Secretary, W. O. Thompson, New York Central.

Treasurer, C. B. Conger, of Wm. Sellers & Co.

Executive Committee members, J. C. Petty (N. Y. C. & St. L.), F. C. Thayer (Southern), and V. C. Randolph (Erie).

The Efficiency of Milling Cutters

A RECOMMENDATION TO INCREASE THEIR TOOTH SPACE AND DEPTH WHICH HAS MANY APPEALING FEATURES, AND WILL NO DOUBT FURTHER ENHANCE THE VALUE OF THIS IMPORTANT MACHINE TOOL.

The rapidly extending use of the milling machine, and particularly the inroad which it has made into the field heretofore exclusively occupied by the planer, has awakened a general interest in a tool which formerly was far from being considered as one of a wide range of efficiency. From the position it once occupied in the railroad shop, as what might be termed a luxury, it has come to be regarded as a practically indispensable adjunct, and the progress of its development is probably being accorded more attention than is given to any other machine tool at the present time.

It is very interesting in this connection to note that while the prevailing design of bed, drive and the essential features are such that little further improvement can be reasonably looked for, there still remains an extensive field for experiment and ingenuity in the development of the cutters. This subject is now being given very careful consideration in many quarters and several elaborate tests are under way in shops of the machine tool builders with the end in view to determine what course shall be followed to increase the efficiency of the cutters.

The milling of metallic surfaces of course requires a rotating cutter provided with one or more teeth having an edge and temper suited to the nature of the material operated upon. Great hardness of the material to be cut, or a dull tool, will severely strain the machine and so reduce the section of the chip, even if the machine is rigidly constructed and well supplied with driving power. It is therefore of the greatest importance to analyze carefully all the conditions which cause heavy strains so that they may be obviated or reduced to the lowest possible limit.

These considerations were fully discussed in an extremely valuable paper by A. L. DeLeeuw which was recently presented before the American Society of Mechanical Engineers. It was pointed out that observations of present day practice and a number of experiments indicate conclusively that better results can be had from milling cutters by increasing the tooth space and depth. A number of cutters constructed along these lines were tested and it was found that they have a number of points in their favor, among which are a less consumption of power, a greater amount of work done for one sharpening and a greater number of possible sharpenings per cutter. A change in the form of chip breaker made it possible to use cutters with chip breakers for finishing, as well as for roughing. This very important addition to existing literature on milling cutters ended with a description of a new style face mill, and what is called a helical mill.

In general, attention is called to the possibilities which lie in a more scentific construction of milling centers and the desirability of discarding ideas which are largely based on conditions no longer existing. In part the paper may be quoted as follows:

> Limitation of the cutting capacity occurs in all metal cutting machines, although to a varying extent. While it is possible to increase the driving power of most machines *ad libitum*, and almost any amount of metal can be put into machine elements to give them rigidity, there are certain classes of machines where practical considerations limit such increase of power and strength. This is especially true in machines where the main elements have to be adjusted and handled with great frequency. The knee-and-column type of milling machine owes its success, to a large extent, to the ease and rapidity with which it can be manipulated, and it is doubtful if it will ever be possible to increase the dimensions of the parts much beyond the present sizes, without losing the benefits of the peculiar construction of this type of machine. In order to increase the capacity of this type of milling machine, it becomes necessary to reduce the strains set up by the cut and there are only two elements which can be modified to accomplish this result. These are the hardness of the metal to be cut and the cutting qualities of the milling cutter. As it is impossible to control the first of these, the only avenue left for improvement leads in the direction of the milling cutter.

The author of the paper then commented at some length on the form of cutters, and in his recommendation that the tooth space should be increased had the following to say, which is of considerable interest:

> It is a common belief that better finish can be obtained with teeth closely spaced, but experience with the wide-spaced cutter shows that there is no ground for this belief. The grade of finish may be expressed by the distance between successive marks on the work. These marks are revolution marks and not tooth marks. It is practically impossible to avoid these revolution marks. They are caused by the cutter not being exactly round or quite concentric with the hole, by the hole not being of exactly the same size as the arbor, by the arbor not being round, by the straight part of the arbor not being concentric with the taper shank, by the taper shank not being round or of the same taper exactly as the taper hole in the spindle, by this taper hole being out of line with the spindle, by looseness between the spindle and its bearings, etc. Each of these items is very small in any good milling machine; yet the accumulation of these little errors is sufficient to cause a mark and this mark needs to have a depth of only a fraction of a thousandth of an inch to be very plainly visible. As these marks are caused by conditions which return once for every revolution of the cutter,

it is plain that the spacing of the teeth can have no effect on the distance between them and, therefore, on the grade of finish.

To test this still further, two cutters of the same size exactly were placed side by side on an arbor. The cutters were ground together, so as to be sure they were of equal diameter, and they were ground on the arbor so as to be sure that the error would appear simultaneously for both cutters. A block of cast iron was finish-milled with these cutters in such a way that each cutter would sweep half the width of the block. The same number of marks appeared on both sides of the block, and these marks were exactly in line with each other, as might have been expected. The grade of finish was the same for both sides. It was neglected to mark the two sides of the casting to see which cutter was operating.

After this test all of the teeth but one of the two cutters were ground lower, so as to be out of action entirely, leaving only one tooth of the one cutter operative. Another cut like the first one was taken over the same block, and again the finish appeared the same on both sides. There was a difference of opinion between different observers as to which side was cut by the single tooth. By close observation, however, a difference could be detected when light fell on the work in a certain direction, under which conditions one side showed more gloss than the other. Straightness, flatness and smoothness to the touch were exactly the same for both sides, notwithstanding that one cutter had one tooth only and the other fourteen teeth. Though it is not recommended here to use cutters with one tooth only for finishing, the foregoing test shows plainly that there is no merit in fine spacing. Attention is again called to the fact, that even though the finish on a single piece *might* be better with more teeth in action, the *average* finish for an entire lot of pieces is better with less teeth.

In further pursuance of the subject the writer of the paper has the following comment to make which may cause some reflection:

However accurately a milling machine may be built, the spindle is not exactly at right angles with the table. The amount of variation from the right angle is very small in a properly built machine, but some variation exists. Besides, this variation is liable to become greater when the machine wears. The result is, that when feeding in one direction the leading teeth of the cutter dig deeper into the work, leaving the other side of the cutter entirely clear, but when feeding in the opposite direction the opposite takes place, which make the teeth drag over the work. In order to provide the teeth with clearance, the back end of the tooth is ground away at an angle of three to five degrees.

The paper included a number of diagrams showing the relative efficiency of different styles of mills for removing a given amount of metal.

As might be expected from the importance of the subject, it was accorded an animated discussion, and in the main the views of the author were agreed with. Mr. Parker believed that the cutter developed by Mr. De Leeuw possesses to a remarkable degree the valuable attribute of saving power, and in certain classes of work, such as heavy manufacturing milling, it will no doubt find a field to which its characteristics are most suited. In regard to the reduction of teeth in the new cutter, he said:

It is evident that the new cutter, having so few teeth, produces a hammering action on the work greater than that of the standard cutter, because there are not sufficient teeth in contact to steady the action; and, unless the machine has the rigidity and massiveness possessed by the heavier class of machines to withstand this pounding effect, the smooth action, so essential to good milling practice, is not obtained. This undesirable feature was very noticeable on a No. 2 Universal milling machine, which is essentially a tool-room machine and necessarily of a light character to enable it to be handled quickly and easily. The pounding was so severe that the tests had to be suddenly terminated, owing to the abusive action to which the machine was subjected. In another machine, somewhat heavier than the one referred to, work, when using the ordinary cutters, could be held in a vise clamped in the usual way; but, with the new cutters it would be pushed bodily out of the vise, and auxiliary means had to be provided to hold it in place. This would indicate that the new cutters would not be suitable for that class of work, when for some reason it could not be so firmly secured as desired, or when great care would have to be exercised in clamping down work to the fixture or machine table, to prevent springing.

A. F. Murray said that Mr. De Leeuw's experiments were in accord with the theories which he had been advocating for several years; and mentioned that at the Blake & Knowles Steam Pump Works they were continually re-cutting old milling cutters for the manufacturing departments and invariably reduce the number of teeth about half, setting the mill deep enough to cut out completely every other tooth. It is his opinion that saws, slotting and side mills, as ordinarily made, have too many teeth, and also that a large proportion of the success obtained by the use of inserted tooth mills has been due to the reduction in the number of teeth.

In concluding the discussion W. S. Huson agreed with the author in the following comment:

We get better results in surface milling from wide-spaced cutting edges than from the usual close-spaced. We have found in testing work milled with cutters having many teeth that when the cut was finished, say at 3 P. M., and tried with straight edge and gages, it was right, while the next morning it was out. There are two causes for this: the peening effect of the cutter, and another which I think is not fully considered, but which I believe is borne out by experience, namely, that the teeth of a milling cutter punch or force little particles of cutting dust into the interstices or pores of the iron, which finally respond to the force exerted on them, and throw the work out of alignment. A cutter with fewer cutting edges for surface milling does not give a bright finish, but the product requires less subsequent filing and fitting. It is for this reason that the question of milling cutters is paradoxical, for in the case of gear cutters with many cutting edges we get a smoother gear tooth, whereas in surface milling we get a truer surface with fewer edges. I agree with the paper that in surface milling the fewer cutting edges, the more chip clearance, and hence the more permanent, if not quite so smooth, work will give better final results than cutters with close-spaced edges. The amount of power consumed is of little importance in the final cost, if as a result of rapid machine output, manual labor must be used to make the work acceptable.

In all probability this valuable paper and the discussion accorded it will have a material bearing on the consideration of the best form of milling cutters, and any improvement in this line means, of course, a further increase in the range of work now possible with this important machine tool. As it stands now, the advantage of the milling machine over the planer lies very largely in its ability to produce, with reasonable accuracy, a large number of duplicate surfaces, the formed cutter and the removal of personal error in making of measurements by the operator being the factors that enable it to produce these results. After an operator, however, has become skilled in its use and thoroughly familiar with its every detail, he can appreciate the great capabilities of this class of machine tools.

SPECIAL FREIGHT CAR OF LARGE CAPACITY

Great difficulty has been experienced by the Westinghouse Electric & Mfg. Co. in obtaining cars that will permit the shipping of large transformers completely assembled. Although special cars have been arranged for this purpose a recent order of 15 transformers were too large in size and weight for any of the cars now in existence, and it was necessary to design and have built three cars with a depressed center giving the minimum distance from floor to rail and at the same time a carrying capacity of 150,000 lbs. concentrated in the center well. These cars were built by the Atlas Car & Mfg. Co., of Cleveland, the design being the combined product of the builders and owners, it also being submitted for approval to the Pennsylvania Railroad. They are entirely of steel, 35 ft. in length, and have a maximum capacity when loaded over the trucks as well as in the center of 205,000 lbs. The floor at the center is but 2 ft. 2 in. above the top of the rail, there being a clearance of 7 in. between the bottom of the sills and the rail.

As will be seen by reference to the detailed drawings, the construction of the car is very simple, consisting of four longitudinal girders, the center ones continuous between bolsters and the side ones continuous for the full length of the car. These longitudinals are connected and stiffened by numerous diaphragms and the bolster, which is of very heavy but simple construction.

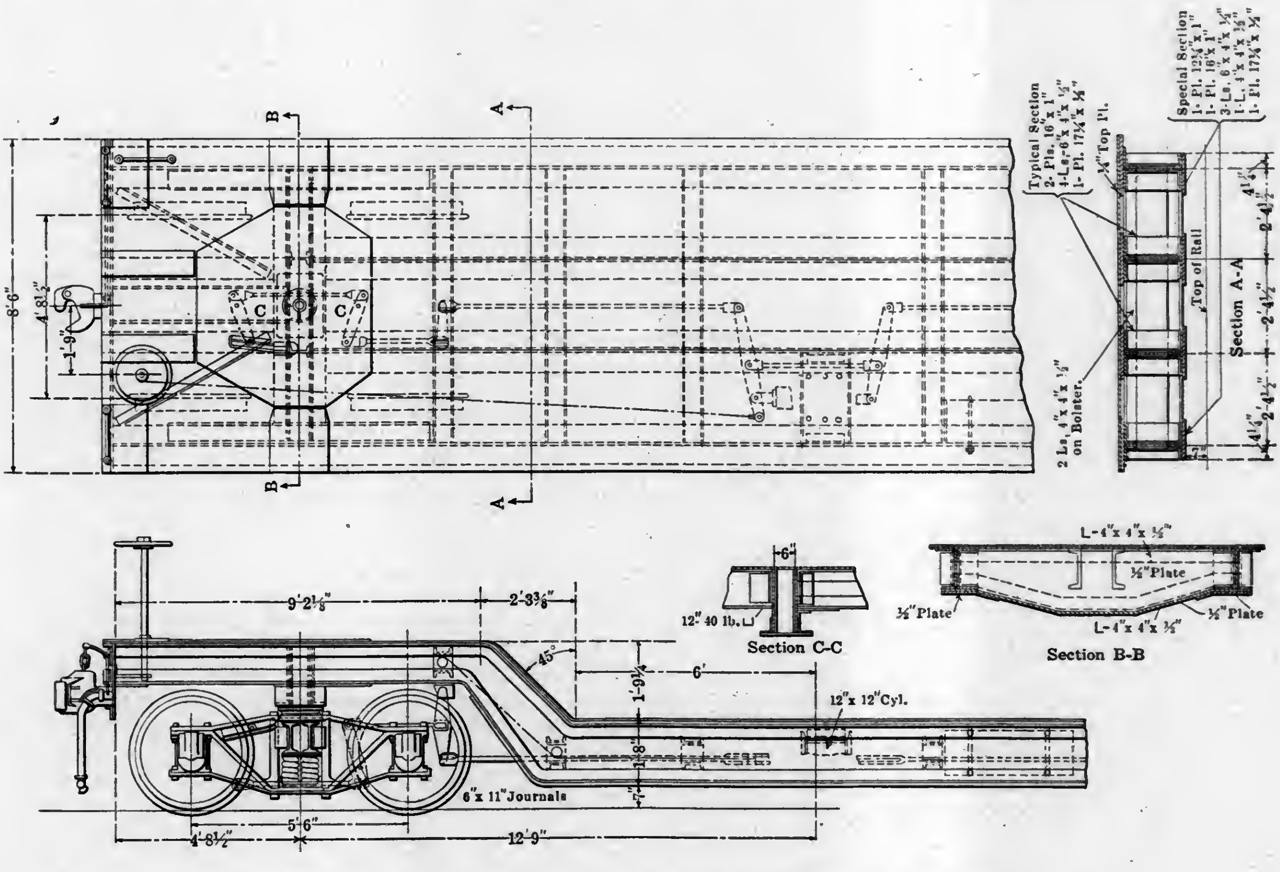
One-half inch plate is used in the web of all the longitudinals, being cut to the shape and size shown in the side elevation of the car. The two center girders have two 6 x 4 x ½ in. angles top and bottom, with a 16 x 1 in. top and bottom cover plate. These cover plates are carried continuous between bolsters at

the top rail and nearly to the top of the inclined section at the bottom. The side girders are the same with the exception that a 4 x 4 x ½ in. angle is substituted for one of the 6 x 4 x ½ in. angles at the bottom and the cover plate is but 12¼ in. wide on the bottom. The diaphragms are all ¼ in. plate with 4 x 3 x ⅜ in. angles and are located as shown in the illustration. At the bolster the construction consists of two ½ in. web plates formed to proper shape and spaced 6 in. apart and four 4 x 4 x ⅜ in. angles with a ½ in. cover plate at the bottom and a ¼ in. plate at the top. I-beam separators are framed vertically between the web plates at the connection with the center sills and extra heavy angles are used for connecting the bolsters with the continuous side sills. The end sill is formed of ½ in. plate with 4 x 3 x ⅜ in. angles, as shown. A ¼ in. plate covers the entire top of the car, having countersunk rivets wherever necessary.

Special trucks with 6 x 11 in. journals have been designed following the M. C. B. requirements in every particular. The wheels are 33 in. in diameter, of rolled steel, and weigh approximately 750 lbs. The total weight of the car is 53,000 lbs., and it is provided with Westinghouse type S. brake having a 12 x 12 in. cylinder. This will brake 85 per cent. of the light weight of the car with an 8 to 1 reduction.

STEEL CAR OF 205,000 LBS. CAPACITY.

RAPID GROWTH OF STEEL CARS.—According to authentic reports there were in use in this country on December 31, 1910, 54,609 passenger cars of which 2,927, or 5.3 per cent., were of all-steel construction. Besides the latter there were 1,481 or 2.7 per cent. built with steel underframes. The rapid growth of the all-steel passenger equipment is best understood when it is known that of the 2,000 passenger cars ordered in 1909, about 24 per cent. were of steel construction and 21 per cent. were built with steel underframes, and in 1910 there were 3,783 new cars acquired, of which 63 per cent. were all steel and 14 per cent. were of steel underframe construction. This shows a rapid growth in sentiment for the steel car. This fact is emphasized by the statistics which show that at the close of 1908 only four-fifths of one per cent. of all the passenger equipment was of all-steel construction.



SPECIAL TRANSFORMER CAR HAVING A CAPACITY OF 150,000 LBS. IN THE CENTER.

it is plain that the spacing of the teeth can have no effect on the distance between them and, therefore, on the grade of finish.

To test this still farther, two cutters of the same size exactly were placed side by side on an arbor. The cutters were ground together, so as to be sure they were of equal diameter, and they were ground on the arbor so as to be sure that the error would appear simultaneously for both cutters. A block of cast iron was finish-milled with these cutters in such a way that each cutter would sweep half the width of the block. The same number of marks appeared on both sides of the block, and these marks were exactly in line with each other, as might have been expected. The grade of finish was the same for both sides. It was neglected to mark the two sides of the casting to see which cutter was operating.

After this test all of the teeth but one of the two cutters were ground lower, so as to be out of action entirely, leaving only one tooth of the one cutter operative. Another cut like the first one was taken over the same block, and again the finish appeared the same on both sides. There was a difference of opinion between different observers as to which side was cut by the single tooth. By close observation, however, a difference could be detected when light fell on the work in a certain direction, under which conditions one side showed more gloss than the other. Straightness, flatness and smoothness to the touch were exactly the same for both sides, notwithstanding that one cutter had one tooth only and the other fourteen teeth. Though it is not recommended here to use cutters with one tooth only for finishing, the foregoing test shows plainly that there is no merit in fine spacing. Attention is again called to the fact, that even though the finish on a single piece *might* be better with more teeth in action, the *average* finish for an entire lot of pieces is better with less teeth.

In further pursuance of the subject the writer of the paper has the following comment to make which may cause some reflection:

However accurately a milling machine may be built, the spindle is not exactly at right angles with the table. The amount of variation from the right angle is very small in a properly built machine, but some variation exists. Besides, this variation is liable to become greater when the machine wears. The result is, that when feeding in one direction the leading teeth of the cutter dig deeper into the work, leaving the other side of the cutter entirely clear, but when feeding in the opposite direction the opposite takes place, which make the teeth drag over the work. In order to provide the teeth with clearance, the back end of the tooth is ground away at an angle of three to five degrees.

The paper included a number of diagrams showing the relative efficiency of different styles of mills for removing a given amount of metal.

As might be expected from the importance of the subject, it was accorded an animated discussion, and in the main the views of the author were agreed with. Mr. Parker believed that the cutter developed by Mr. De Leeuw possesses to a remarkable degree the valuable attribute of saving power, and in certain classes of work, such as heavy manufacturing milling, it will no doubt find a field to which its characteristics are most suited. In regard to the reduction of teeth in the new cutter, he said:

It is evident that the new cutter, having so few teeth, produces a hammering action on the work greater than that of the standard cutter, because there are not sufficient teeth in contact to steady the action; and, unless the machine has the rigidity and massiveness possessed by the heavier class of machines to withstand this pounding effect, the smooth action, so essential to good milling practice, is not obtained. This undesirable feature was very noticeable on a No. 2 Universal milling machine, which is essentially a tool-room machine and necessarily of a light character to enable it to be handled quickly and easily. The pounding was so severe that the tests had to be suddenly terminated, owing to the abusive action to which the machine was subjected. In another machine, somewhat heavier than the one referred to, work, when using the ordinary cutters, could be held in a vise clamped in the usual way; but, with the new cutters it would be pushed bodily out of the vise, and auxiliary means had to be provided to hold it in place. This would indicate that the new cutters would not be suitable for that class of work, when for some reason it could not be so firmly secured as desired, or when great care would have to be exercised in clamping down work to the fixture or machine table, to prevent springing.

A. F. Murray said that Mr. De Leeuw's experiments were in accord with the theories which he had been advocating for several years; and mentioned that at the Blake & Knowles Steam Pump Works they were continually re-cutting old milling cutters for the manufacturing departments and invariably reduce the number of teeth about half, setting the mill deep enough to cut out completely every other tooth. It is his opinion that saw slotting and side mills, as ordinarily made, have too many teeth and also that a large proportion of the success obtained by the use of inserted tooth mills has been due to the reduction in the number of teeth.

In concluding the discussion W. S. Huson agreed with the author in the following comment:

We get better results in surface milling from wide-spaced cutting edges than from the usual close-spaced. We have found in testing work milled with cutters having many teeth that when the cut was finished, say at 3 P. M., and tried with straight edge and gages, it was right, while the next morning it was out. There are two causes for this: the peening effect of the cutter, and another which I think is not fully considered, but which I believe is borne out by experience, namely, that the teeth of a milling cutter punch or force little particles of cutting dust into the interstices or pores of the iron, which finally respond to the force exerted on them, and throw the work out of alignment. A cutter with fewer cutting edges for surface milling does not give a bright finish, but the product requires less subsequent filing and fitting. It is for this reason that the question of milling cutters is paradoxical, for in the case of gear cutters with many cutting edges we get a smoother gear tooth whereas in surface milling we get a truer surface with fewer edges. I agree with the paper that in surface milling the fewer cutting edges, the more chip clearance, and hence the more permanent, if not quite so smooth, work will give better final results than cutters with close-spaced edges. The amount of power consumed is of little importance in the final cost, if as a result of rapid machine output, manual labor must be used to make the work acceptable.

In all probability this valuable paper and the discussion accorded it will have a material bearing on the consideration of the best form of milling cutters, and any improvement in this line means, of course, a further increase in the range of work now possible with this important machine tool. As it stands now, the advantage of the milling machine over the planer lies very largely in its ability to produce, with reasonable accuracy, a large number of duplicate surfaces, the formed cutter and the removal of personal error in making of measurements by the operator being the factors that enable it to produce these results. After an operator, however, has become skilled in its use and thoroughly familiar with its every detail, he can appreciate the great capabilities of this class of machine tools.

SPECIAL FREIGHT CAR OF LARGE CAPACITY

Great difficulty has been experienced by the Westinghouse Electric & Mfg. Co. in obtaining cars that will permit the shipping of large transformers completely assembled. Although special cars have been arranged for this purpose a recent order of 15 transformers were too large in size and weight for any of the cars now in existence, and it was necessary to design and have built three cars with a depressed center giving the minimum distance from floor to rail and at the same time a carrying capacity of 150,000 lbs. concentrated in the center well. These cars were built by the Atlas Car & Mfg. Co., of Cleveland, the design being the combined product of the builders and owners, it also being submitted for approval to the Pennsylvania Railroad. They are entirely of steel, 35 ft. in length, and have a maximum capacity when loaded over the trucks as well as in the center of 205,000 lbs. The floor at the center is but 2 ft. 2 in. above the top of the rail, there being a clearance of 7 in. between the bottom of the sills and the rail.

As will be seen by reference to the detailed drawings, the construction of the car is very simple, consisting of four longitudinal girders, the center ones continuous between bolsters and the side ones continuous for the full length of the car. These longitudinals are connected and stiffened by numerous diaphragms and the bolster, which is of very heavy but simple construction.

One-half inch plate is used in the web of all the longitudinals, being cut to the shape and size shown in the side elevation of the car. The two center girders have two 6 x 4 x ½ in. angles top and bottom, with a 16 x 1 in. top and bottom cover plate. These cover plates are carried continuous between bolsters at

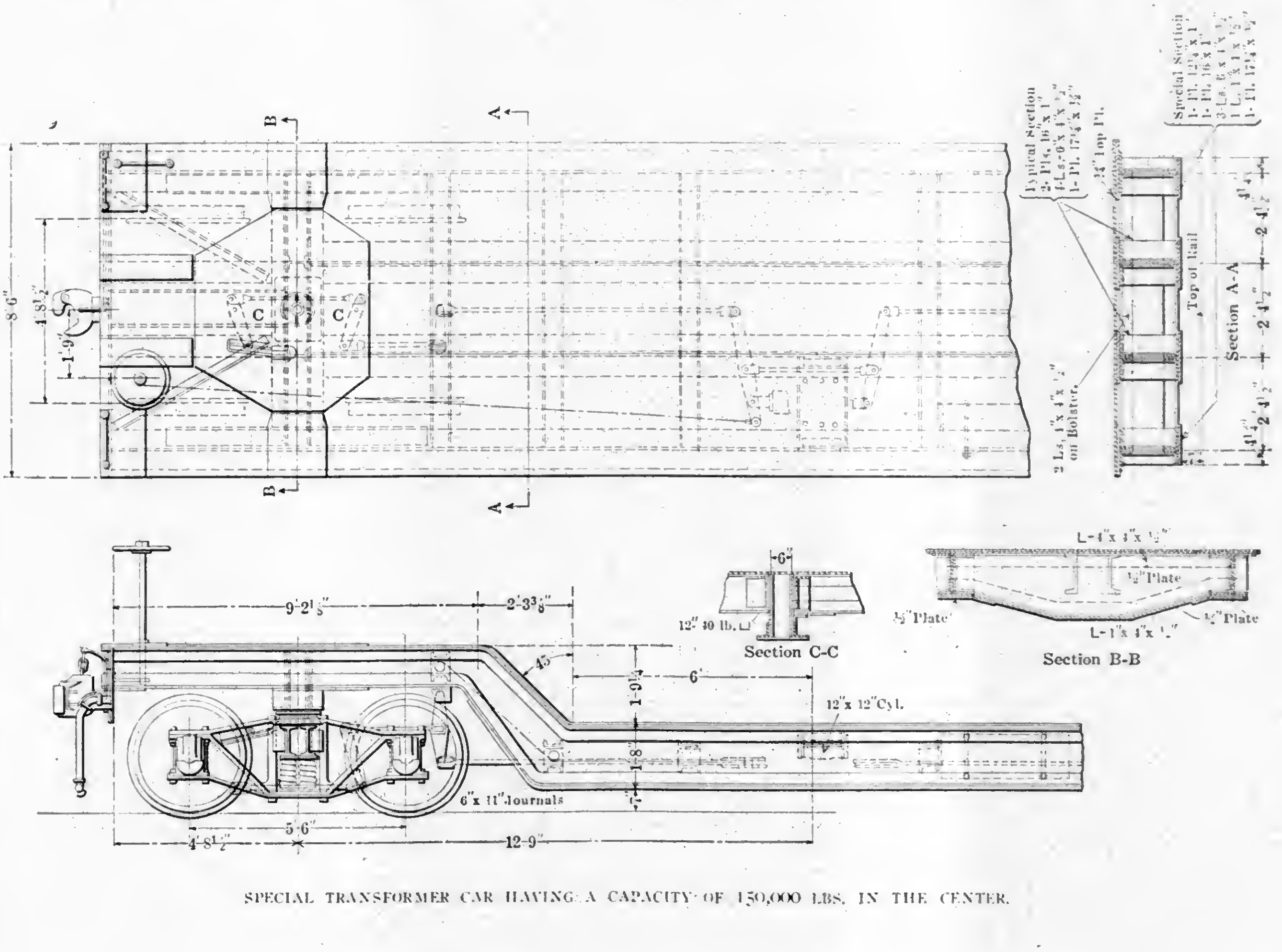
he top rail and nearly to the top of the inclined section at the ottom. The side girders are the same with the exception that 4 x 4 x 1/2 in. angle is substituted for one of the 6 x 4 x 1/2 in. ngles at the bottom and the cover plate is but 12 1/4 in. wide on he bottom. The diaphragms are all 1/4 in. plate with 4 x 3 x 3/8 n. angles and are located as shown in the illustration. At the olster the construction consists of two 1/2 in. web plates formed

STEEL CAR OF 205,000 LBS. CAPACITY.

to proper shape and spaced 6 in. apart and four 4 x 4 x 3/8 in. angles with a 1/2 in. cover plate at the bottom and a 1/4 in. plate at the top. I-beam separators are framed vertically between the web plates at the connection with the center sills and extra heavy angles are used for connecting the bolsters with the continuous side sills. The end sill is formed of 1/2 in. plate with 4 x 3 x 3/8 in. angles, as shown. A 1/4 in. plate covers the entire top of the car, having countersunk rivets wherever necessary

Special trucks with 6 x 11 in. journals have been designed following the M. C. B. requirements in every particular. The wheels are 33 in. in diameter, of rolled steel, and weigh approximately 750 lbs. The total weight of the car is 53,000 lbs., and it is provided with Westinghouse type S. brake having a 12 x 12 in. cylinder. This will brake 85 per cent. of the light weight of the car with an 8 to 1 reduction.

Rapid Growth of Steel Cars.—According to authentic reports there were in use in this country on December 31, 1910, 54,009 passenger cars of which 2,927, or 5.3 per cent., were of all-steel construction. Besides the latter there were 1,481 or 2.7 per cent. built with steel underframes. The rapid growth of the all-steel passenger equipment is best understood when it is known that of the 2,000 passenger cars ordered in 1909, about 24 per cent. were of steel construction and 21 per cent. were built with steel underframes, and in 1910 there were 3,783 new cars acquired, of which 63 per cent. were all steel and 14 per cent. were of steel underframe construction. This shows a rapid growth in sentiment for the steel car. This fact is emphasized by the statistics which show that at the close of 1908 only four-fifths of one per cent. of all the passenger equipment was of all-steel construction.



SPECIAL TRANSFORMER CAR HAVING A CAPACITY OF 150,000 LBS. IN THE CENTER.

[ESTABLISHED 1832]

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CONTENTS

* Denotes illustrated article.

CARD INDEX HEADINGS

A year ago we started publishing in each issue a list of headings of the important articles in that number, arranged to be conveniently clipped and pasted on the card index cards of those of our subscribers who made a practice of keeping a complete card index. We also felt that these convenient headings might influence some of the younger men to start the habit of maintaining a complete card index of the more important articles in the various technical journals. These headings customarily required the space of about one page, the use of which for this purpose could only be justified by the assurance that they were accomplishing the results desired and were being appreciated and used.

After six months trial we decided, by discontinuing the practice, to determine to what extent these headings were being used and how important they were considered by our subscribers, knowing that such action would immediately bring a remonstrance from those who had found them valuable. We did receive objections from a number of subscribers and have continued to receive them for the past six months, but hardly in sufficient numbers to make us feel fully justified in reviving this section. Feeling that possibly some of our readers have objected to the discontinuance of these convenient headings, but have not felt strongly enough to register a kick, we are in some doubt in the matter and would be very glad indeed to obtain an expression of opinion from all who feel that this section should or should not be revived. The editors believe that these headings should be of value, but as we are publishing a paper for the reader, the matter is entirely in your hands for decision, and we would like to hear from you.

THE TRIUMPH OF THE MACHINE TOOL

The remarkable development to which the modern machine tool has been brought is not, as many imagine, the result of any random growth. On the contrary, each type of to-day represents the culmination of years of experiments and patient research, and of a character so elaborate as to be almost unbelievable. A certain machine tool builder, now deservedly prominent in the mechanical world, worked for over fifteen years in perfecting a heavy duty lathe through which its range of efficiency became easily doubled, although but 20 per cent. has been added to its original cost. Similar instances are plentiful, and are extremely interesting as illustrative of the potent influence of competition in business.

There is litttle doubt but that the machine tool builders of the United States have been foremost in this movement. Within the period previously referred to, fifteen years, driving powers have increased in some instances 300 per cent., while weights have increased say by 100 per cent. at least. The cost of experimenting before this revolution could be brought about has been very great. Recently a firm making milling machines spent over $25,000 in thoroughly testing one size of machine which they were placing on the market. The day appears to be on the wane when a machine tool builder can make any wide range, or various types of tools as the rapid strides in design and re-design would impose costs necessarily prohibitive. It is for this reason that specialization is now so prominent in this important industry, the range noticeable in the instance of several firms not being over two lines of machines.

The mechanical changes which have been made may be briefly summarized as a material strengthening of the old standard designs to secure rapidity of production and obtain accurate results with high-speed steels, and in the introduction of new features in both general and detail design to enable operators to produce rapidly with lessened physical and mental strain.

A prominent feature in modern machine tool designing is one never loverlooked; the convenience of the machine for the operator. Probably the most pronounced feature in this connection is the means of changing the driving speeds and rates

of feeds. The usual method of a stepped cone is disappearing, and its place is being taken by gear boxes of variable-speed motors. Changing by gears is usually arranged to the medium size machine tools, and variable speed motors to the larger machines. The introduction of nearly perfect gear cutting machines and the use of hardened steel gears, with practically perfect continuous lubrication, have made the operation of the gear boxes practically noiseless.

The results of these changes have meant that not only can manufacturing costs be materially reduced, but more satisfaction is given to the workman. Speeding up a slow operator on a slow machine generally leads to friction, whereas on a tool designed with convenient motions an operator soon becomes interested in obtaining a rapid production.

As the machine tool designer has responded to the call for accuracy, there is now no longer any excuse for shop practice not providing correct work, and it is of course an admitted fact that accuracy is now possible and insisted on to a degree unknown only a decade ago. The American machine tool as it stands to-day is a monument to the patience, experience and ingenuity of its makers, and who are yet unceasingly striving toward further perfection.

THE MOUNTAIN TYPE LOCOMOTIVE

What a successful stoker means in locomotive design and train operation is well indicated by the new locomotives recently completed by the American Locomotive Company and put into service on the Chesapeake & Ohio Railway, which have been christened the "mountain" type. These locomotives have been deliberately designed to perform a service which practically requires the successful operation of a locomotive stoker and the accepting of the design by the railroad is the best evidence presented so far that the stokers have reached the stage where confidence can be placed in their reliability.

A Pacific type locomotive, having a total weight of 216,000 lbs. and a tractive effort of 32,000 lbs., is, even in these days, considered a large locomotive, and when there is presented the design of a simple engine which will easily do the work of two of these, a feeling somewhat akin to doubt is aroused, but the facts are present in this case and the locomotives are actually handling 12 cars on a schedule and over a division where the Pacific types have been handling only six cars. What this means to the operating department, of course, is easily conjectured and it is to be hoped that the men who have worked so long and conscientiously in developing the stoker are given the credit which they deserve, together with the designers of the machine itself and the officers of the motive power department for making such results possible.

In addition to its enormous power and its position as the largest simple locomotive in the world there are a number of other features in the design which make it of decided interest. Possibly the most prominent of these is the screw reverse gear, this being the first time this arrangement has been used in regular service in this country, although the American Locomotive Company applied it experimentally some time ago. The gear as arranged in this case takes but about six seconds for a complete reversal and it is stated that after becoming acquainted with it the enginemen recognize its evident advantages and favor it. Because of its extreme simplicity and positiveness of action it is probable that this type of gear now, once having broken the ice, will be used to a considerable extent on future heavy locomotives.

There have been cases where double heading of important trains has been resorted to, particularly in cold weather when one of the locomotives had ample power to handle the train alone, because of the impossibility of it going the full division without stopping to empty the ash pan. It is comparatively easy to figure from the quality of coal what the limits of continuous service are for a certain locomotive operating under any specified conditions. In the case of these mountian types which do the work and burn the coal of two Pacific type locomotives it would be readily apparent that they of necessity must have an ash pan of practically double the size if they are to run for the same distance. The designers have solved this question, however, apparently in a very satisfactory manner and have applied to this locomotive a pan having 83 cu. ft. capacity, arranged in six hoppers, four of which are outside the frames.

THE PHILOSOPHY OF SHOP MISTAKES

Human fallability to err is prominent in practically every walk of life, and those in railroad service, despite the voluminous rules laid down for their guidance and their own characteristic loyalty and high sense of duty, are by no means exempt. Blunders are committed from the highest in supervising capacity to the lowest. For many of them no explanation can be given. They are so inexplicable in view of the knowledge and experience known to be possessed by the person at fault that in the large majority of instances they are either condoned or forgiven.

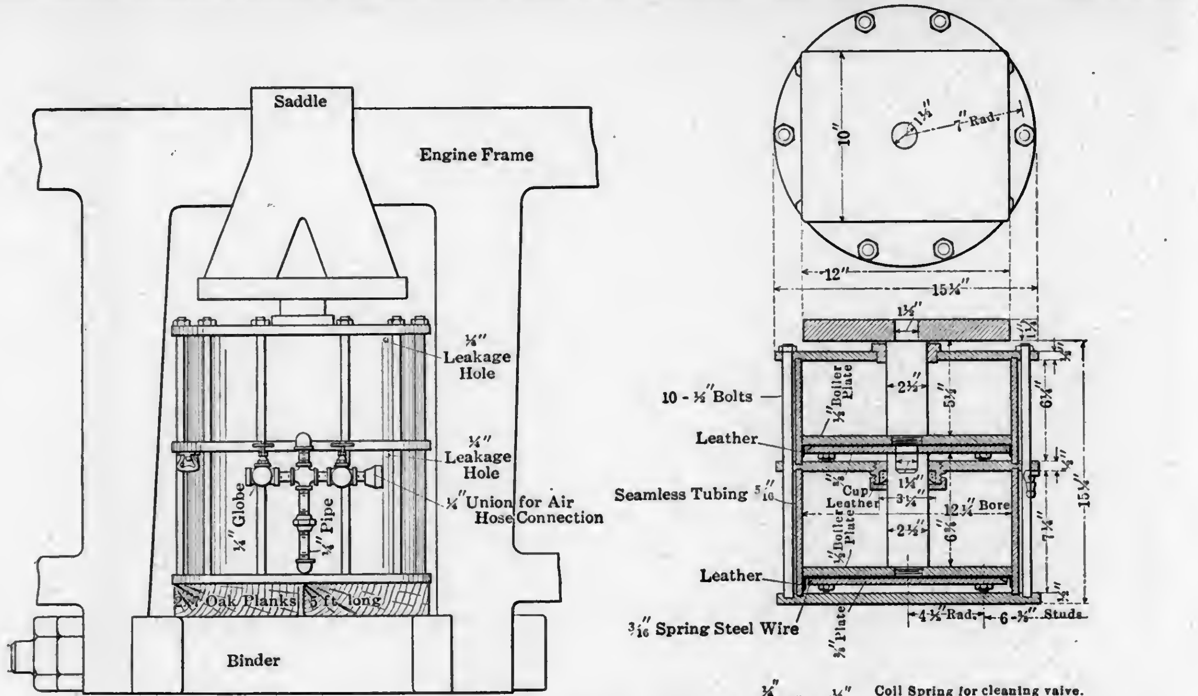
If those in authority are thus at times remiss it is but natural to assume that the rank and file, through probably a lessened sense of responsibility would be even more so, but singularly enough the reverse is the case. It is really astonishing to note the immunity from mistakes which prevails in the conduct of any railroad shop. When a man has been guilty of such it becomes a lurid light of warning whenever a job comes along wherein a similar error might be possible. The original blunder is never forgotten, and it is certainly a fact that no mechanic will commit the same error twice. There is nothing a man who has regard for his reputation dreads more than the discovery of blunders in his own work or in that of a department of which he is in charge. The feeling begotten is one of chagrin, as though some status were lost, and the majority of errors look so silly when discovered that they cause their perpetrator to feel very small.

Generally a man's position is not imperiled by an occasional mistake, even though it be a big one, and little, as a rule, is said about incipient errors discovered in the progress of work in any one department, but when the work is cleared out into another shop and the knowledge of errors become the public property of the shop, the thing wears a different aspect. The first thought of the foreman, who is rightly held responsible for all that occurs in his shop, is how will his employers regard the matter? Especially is this so when two or three mistakes follow in rapid succession. It matters little how many hundreds of errors he has detected and prevented in the face of the one or two that unfortunately pass his keen scrutiny. A single blunder overshadows ninety-nine good works, and, though condoned, he feels that it stands for a long time a black mark against him.

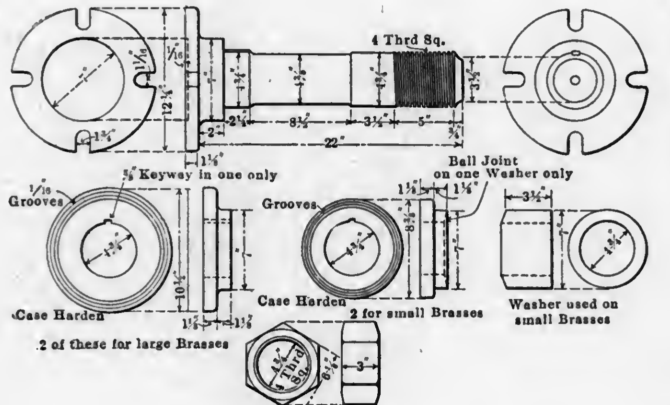
There is a great difference in managers in their treatment of men who have blundered. Broad views are taken as a rule. Some do not utter any reproach to a trusty and well-tried man, but simply discuss the best methods of repairing the error. Some lose their temper momentarily, but forget afterwards, while some draw a long face and utter the obvious truism that it is a serious matter, and that the workman who did it should be discharged. This latter procedure, however, is seldom in evidence, as from what has been said it is appreciated that the compunction of the offender will serve as an adequate punishment.

In a general or average sense all blunders are preventable, and yet a certain percentage is made in every shop during a year and always will be. The lesson taught by them is the same which all have to learn in the conduct of life. No one is exempt from mistakes, but these become danger signals to prevent or lessen the recurrence of like errors.

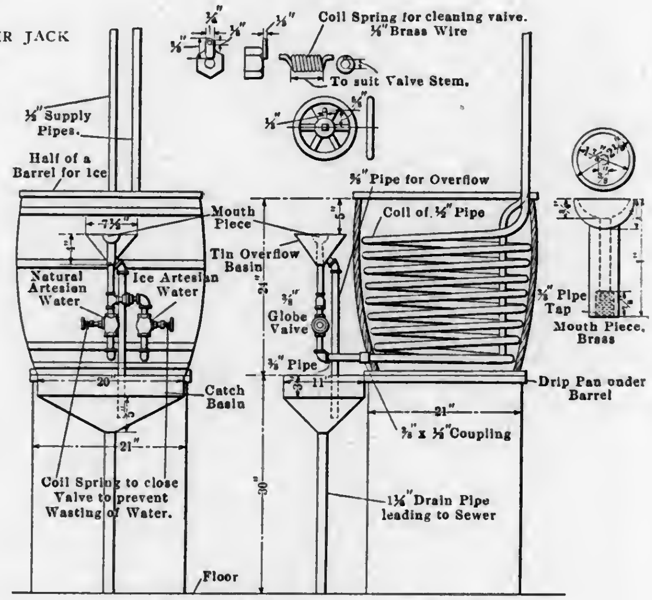
It is the everlasting tribute to the American railroad or shop man that he appreciates this lesson, and while bitter at the time every mistake has its corrective value as an insurance against repetition.



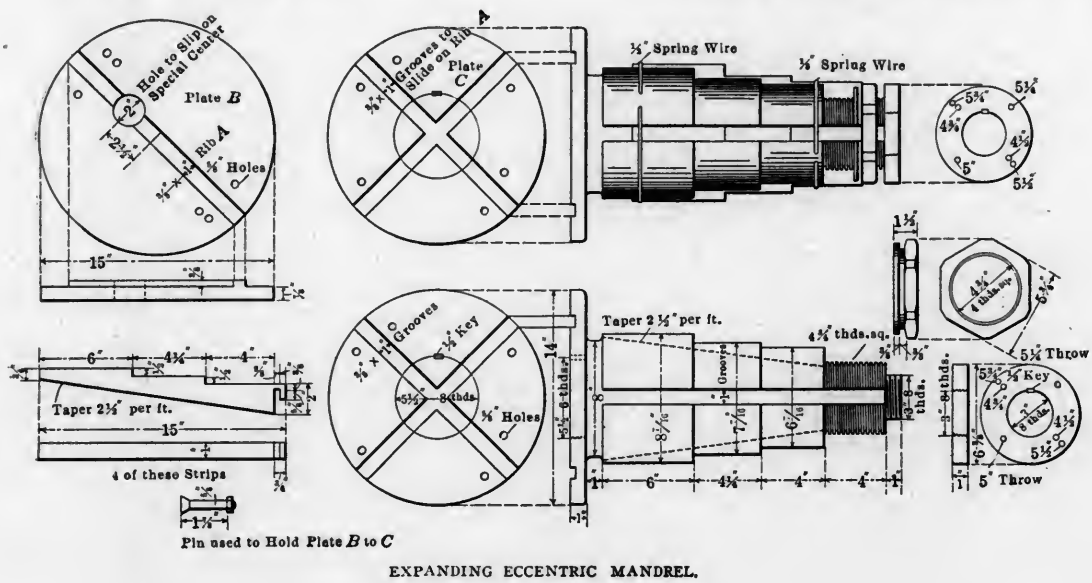
DOUBLE AIR JACK



DRIVING BOX BRASS MANDREL.



SANITARY SHOP DRINKING FOUNTAIN.



EXPANDING ECCENTRIC MANDREL.

SOME NEW JIGS AND METHODS

CHICAGO & NORTH-WESTERN RY.

The Chicago and North-Western Ry. has of late developed many ingenious labor-saving devices in connection with shop work which are entitled to particular consideration. While some of these may not be generally applicable, they are still of sufficient interest to be briefly described and illustrated for whatever value each may have to those who are combating the problem which each represents.

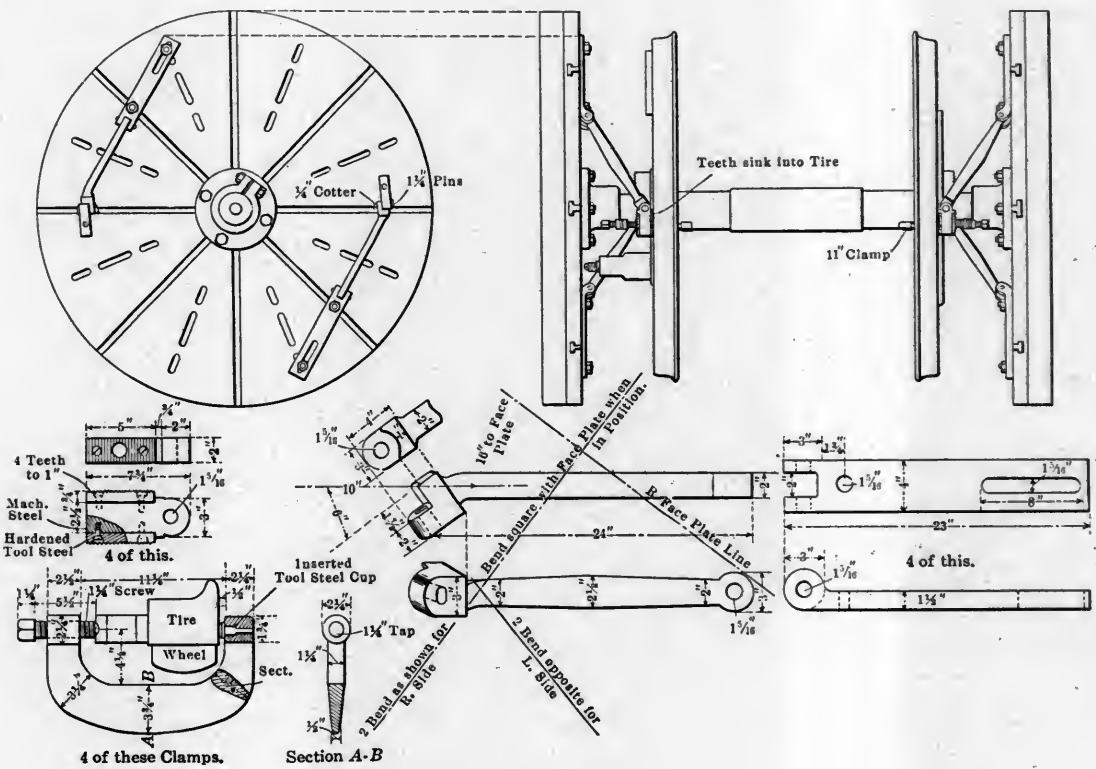
Prominent among those herein illustrated which have been evolved by the various foremen and master mechanics of the railroad, but largely at the Clinton shops, is the double air jack for blocking up springs under Atlantic type engines with fairly wide pedestals. The operation in general wherein the jack is used is a drop pit proposition pure and simple, and the intent is to relieve the drop pit jack of all work other than that required to merely pump the drivers from the pit into their normal position.

The construction of this small jack, as will be readily noted from the drawing, is such that it can be introduced within the frame pedestal, being only 15¼ in. in diameter, with a bore of 12¼ in., and it will lift as much as a single jack of 19 in. diameter. This jack as illustrated has a partition between the two cylinders, with packing leather around the piston rod to confine the air independently to each cylinder. Air is admitted simultaneously through a ¼ in. globe valve. A ¼ in. leakage hole is placed in the top of each cylinder to prevent the equalizing of air. The constructive details need not be further commented upon as they can be readily understood from the drawing.

In connection with this device the idea might reasonably suggest that its use would be unnecessary provided that the saddle had been blocked as a preliminary, and before any wheel dropping was resorted to, which is true enough, but as is of course understood it frequently becomes necessary while an engine is on the drop pit to change springs or hangers and in such contingency the device must prove of considerable value.

The driving box brass mandrel shown herewith in detail is in very successful operation in the Clinton shop of this road, where through its use a brass for a 9½ in. by 12 in. journal can be turned up in twelve minutes, taking a roughing and a finishing cut. This quick time is realized by the size of the arbor and its weight. This is fastened and carried by the lathe face plate, which also centers that end of the mandrel by a recess in the face plate and a shoulder on the bar. The brass is held in place by the two washers and large nut. The majority of railroad shops use mandrels held on centers and driven by a dog, a known to be unsteady arrangement which factor this new design is intended to eliminate. It is very highly commended where used, both for ease of operation and for its substantial construction.

Another interesting device of somewhat similar character is the expanding eccentric mandrel which is very clearly shown in the accompanying detail drawing. The arrangement provides for a very solid drive. It is quickly applied to a lathe and produces work of remarkable accuracy. It will be noted that the wings are adjustable to all sizes of eccentric bores, adjustment being made by screwing in or out the large 4¾ in. nut. The 6⅜ in. plate that is screwed on the end of the mandrel is laid out and centered for all eccentric throws. The other end of the mandrel slides up and down on a grooved plate, the latter also having holes to correspond with all eccentric throws. The eccentric is held from turning on the mandrel by its set screws and the drive is effected from the face plate by strap and bolts.



DRIVE FOR WHEEL LATHE.

The sanitary shop drinking fountain herewith illustrated does not embody any particular novelties in design, as the coil system has been used generally in shops for many years to cool drinking water, but it is included among the special devices principally on account of its simplicity, and in recognition of the fact that it can be produced at a very low cost. The principal feature is, of course, the fountain, and with reasonable care it should not be wasteful of water. As a precaution against this the valve stems are fitted with coil springs which automatically close the valve when the handhold is released. It is also clear from the drawing that the water does not mix with the ice, the latter being broken up and packed around the pipe coil.

The funnel shown catches all waste water which is conducted to a sewer or any convenient point.

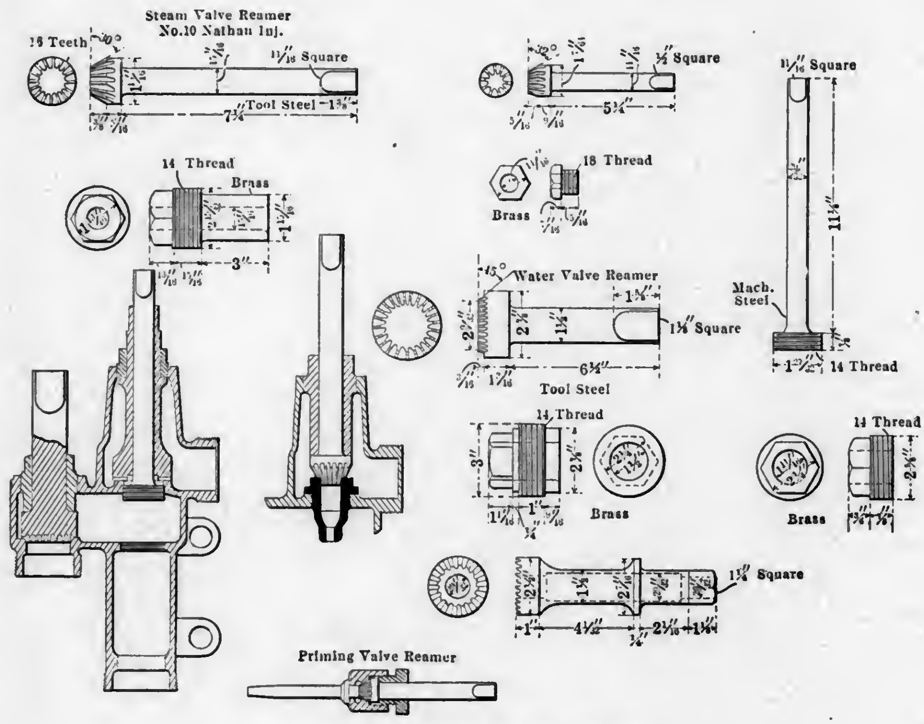
In connection with this arrangement it might be said that railroad shops as a rule are surprisingly lax, in view of the general agitation over sanitary drinking facilities, in making suitable provision in this line for the shop men. Existing appliances in this line range from a chunk of ice in a bucket, with the accompaniment of a common dipper, to a metal cooler with chained tin cup attached. It need not be mentioned that the ice which is in direct contact with the water is seldom if ever washed, and the drinking cup never. With these considerations in mind this cheap and undoubtedly economical fountain becomes of interest.

A first-class home-made wheel lathe drive has been evolved in the Clinton shop which is not by any means the least interesting example of the ingenuity displayed in that quarter. The details are so clearly apparent in the drawing that little

standardize the various operations that the least possible expenditure of time and money is assured.

The Chicago and North-Western Ry. has been actively engaged in this latter work for some time, and is now handling by special standard reamers all re-seating which injectors generally require when they pass through the shop. A set of these tools which are used in connection with the maintenance of the Nathan "No. 11" injector is shown in the accompanying illustration. These tools are used by hand, simply by being turned a few times and fed to the work by the nuts as shown. They are not only great labor savers, but embody the additional valuable feature of insuring that the seats are maintained on their original angle. Without them it would be necessary to put the injector in a lathe, which is a cumbersome undertaking, and generally implies an unsatisfactory job with much after grinding.

The large tool in the drawing which lines up the flat seat



STANDARD INJECTOR REPAIR TOOLS.

description is necessary. It is quite evident that the heavier the cut the tighter the steel dogs must grip into the tire. The range of the appliance is remarkable as it will drive from 42 to 74 inches, simply by sliding the dogs in or out on the face plate. When the wheel is being put into or taken out of the lathe the dogs swing back against the face plate, leaving free opening. The dogs are held against the tire by four horseshoe clamps as shown. From what can be learned of the operation of this device it is considered to be far superior to a spoke drive from the face plate, the well-known objection to which being that it is not constant, and necessarily of a more or less unsteady character. The only objection which might be advanced against its use is the scarring of the tire by the teeth of the dogs, but this is so slight that it need scarcely be considered. It is really astonishing that this is not more apparent, but in the case of some of the heaviest cuts the tires scarcely show a mark.

On a division having say 150 locomotives the question of injector repairs resolves into considerable proportions; one which needs to be dealt with intelligently, and with the aid of special devices to result in a smooth and satisfactory handling. In instances where the various types of injectors are restricted the repair department dealing with that item is fortunate in being able to hold its special reamers, etc., to a minimum, and to so

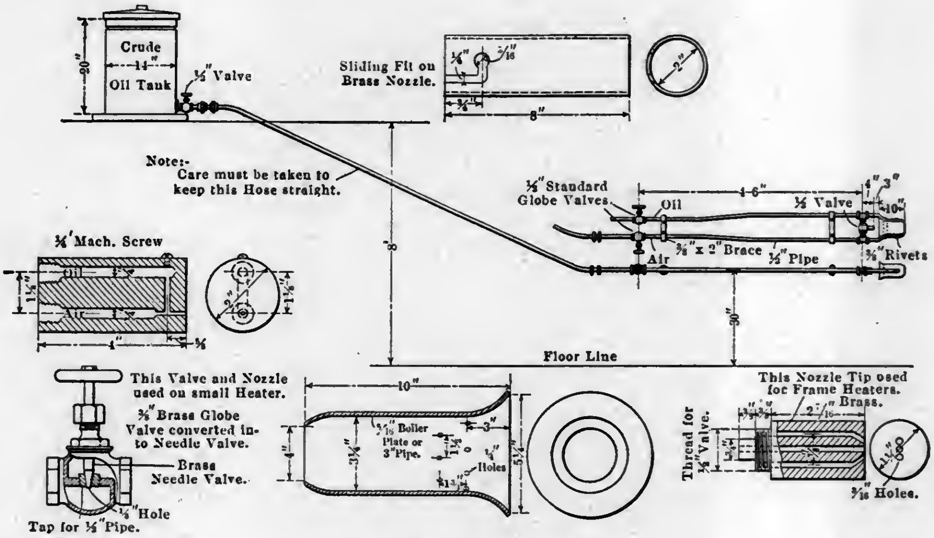
for the steam valve, has its steel spindle threaded to fit the threads in the body of the injector where the steam nozzle screws in. This spindle centers and guides the flat seated reamer, the latter being drilled through its center to fit the spindle. The reamer being thus held in line it is fed by the nut screwed in the bonnet opening on the injector. It will be noted that the water valve reamer is designed to cut down the top of the seat at the same time the bevel is being formed, thus keeping the seat always the same width. These tools were designed by H. Killean, tool maker, at the Clinton shop, and have greatly simplified the operations heretofore associated with such repairs.

A dependable crude oil heater is now generally recognized as a valuable accessory to shop and especially roundhouse equipment, in view of the occasions which frequently arise where it could be employed to great advantage in obviating the removal of a part for heating with the accompanying delay and expense. For instance, bent channels on tenders, cars, etc., frequently require this treatment, and in particular the oil welding under the engine of broken frames, which is now practiced on several railroads, necessitates an appliance which will raise the part to be worked on to the desired temperature quickly and cheaply.

The heater illustrated herein is also a product of the Clinton shop and is being used at that point with great success. Its ex-

treme simplicity is readily apparent in the drawing, so that no description is necessary.

To operate it the oil tank is partly filled with crude oil, and is simply placed higher than the piece to be heated. If a short, quick heat is required a few fire bricks are usually placed around and over the part as a preliminary. When ready all that is necessary is to open the oil and air valves and a piece of burning waste at the burner will start operations. The only manipulation required for the device is that of securing the proper regulation for the two valves mentioned.



CRUDE OIL TIRE HEATER.

While crude oil heaters are far from being a new idea, either in theory or practice, it is believed that the one under consideration embodies less complexity and is cheaper and more substantial than the general run of such devices which may be encountered in railroad shops.

WESTINGHOUSE NEW AIR BRAKE PLANT

The Westinghouse Air Brake Company has just closed negotiation for the purchase of a site at Emeryville, Cal., upon which it is soon to commence the erection of a large plant for the manufacture of its various products. Negotiations for the purchase have been under way for more than a year, but have only recently been closed.

For a long time it has been recognized that the company needed a plant on the Pacific Coast in order that it might be in a position to serve the needs of Japan, Manchuria and other Oriental countries in a more efficient and prompt manner than has been possible in the past. It is stated that the use of air brakes manufactured by the company is becoming more popular each year in the countries mentioned and the demand has become so large that it was not practicable to ship such product from the East clear across the continent and reship them from the Pacific Coast.

The trouble has been that being shipped so far in many instances considerable damage was done to machinery en route and it was feared that such results would result unfavorably in time unless rectified. The Westinghouse Air Brake Company intends to push its Oriental trade to a greater extent as soon as its California plant is completed. It is expected that there will be a liberal demand for the company's product as soon as the Oriental people become educated up to the fact that it will be possible and that the goods will be received in good condition.

THE RAILWAY BUSINESS ASSOCIATION

The members of the Railway Business Association have received notice of the third annual dinner, which will conclude the annual meeting on Wednesday, November 22, 1911, at the Waldorf-Astoria, New York.

The notice reads as follows:

"On this occasion, speakers of the first prominence, representing each a phase of the live railway problems of the hour, will unite in a notable exercise of influence upon public thought and sentiment toward transportation and industry. The guests will include an impressive representation of our national leaders in transportation, industry, commerce, finance, the professions and public life. The prestige from our previous dinners and from our record of conceded accomplishment in constructive publicity will serve to whet the general eagerness to participate in the function of 1911.

"Already the enthusiasm of our members has manifested itself in requests for reservations, though it has been thought fair to inform all such that requisitions could not be received until after the formal announcement of the date had gone to all members alike. There will without doubt be a subscription in excess of the capacity of the dining room, which is definitely limited.

"All companies who are members of the Association are entitled to subscribe for as many seats as they desire for themselves and friends whom they wish to take this opportunity of honoring."

In view of the disappointment suffered by many in 1910 through delay in subscribing, members are advised not to wait for acceptances from invited guests, but to file reservations at once. Announcements will be made at an early date of the names of the speakers.

THE PIONEER LOCOMOTIVE SUPERHEATER.—The earliest recorded attempt at using the principles of superheating was made in 1828 by Richard Trevethick at the Birnie Down Mines in Cornwall, on a condensing pumping engine making eight revolutions per minute, with a boiler pressure of 45 lbs. per square inch. At this slow speed, and with such lagging materials as were in use in those days, the condensation was very great. Trevethick conceived the idea of reheating the steam in the cylinder to re-evaporate the condensation. To attain this end, the cylinder and piping were surrounded with firebrick and heated from a fire on a grate beneath. A remarkable saving was noted; ordinarily 9,000 lbs. of coal were consumed per day, whereas with a fire under the cylinder, only 6,000 lbs. were required, including the coal for the superheating grate. This led to further experiments by Trevethick, resulting in his tubular boiler and superheater in 1832, which, it is claimed, is quite modern in appearance.

AT THE PANAMA CANAL ZONE most of the railroad construction now is done with the assistance of compressed air. All the rivets are driven with air hammers. Other uses—the brake on all the dump cars, the fans, and so on—need not be enumerated.

Oil Burning Passenger Locomotives 2-6-6-2 Type

SOUTHERN PACIFIC COMPANY.

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POWERFUL OIL BURNING PASSENGER LOCOMOTIVE.

Separate type boilers as usually applied by the builders to locomotives of this capacity have been specified. In the present instance, however, the dome is placed a short distance ahead of the firebox, and an internal dry pipe conveys the steam to the intermediate combustion chamber. This chamber contains right and left hand steam pipes of ordinary construction, and these communicate with short outside horizontal pipes, which lead to the top of the high pressure steam chests. The high pressure exhaust is conveyed to the smoke-box through a horizontal pipe located in a large flue which traverses the water heater. The flexible receiver pipe is placed on an angle under the smoke-box.

Inside admission piston valves, of the built-up type 15 inches in diameter, control the steam distribution to all cylinders. No by-pass valves are used, but a large relief valve is tapped into the steam pipe leading to each cylinder. The low pressure pistons have extension rods, and these are supported at their outer ends, on crossheads. The guides for these crossheads are supported by the cylinder heads and cast steel bumper beam. The crossheads have cast steel bodies and bronze gibs, and bear on the tops of the guides only.

Interposed between each high pressure cylinder and the saddle is a slab frame, 26 inches deep and 2½ inches wide. This slab is spliced to the main frame by 21 bolts each 1½ inch in diameter, and by two vertical keys driven in a parallel key-way with their tapered faces in contact. The same plan is used for keying the frames to the cylinders and saddle. The saddle itself is of cast steel and is composed of two sections. The lower section extends the full depth of the slab frames, and supports the hinge pin, which is 7 inches in diameter. With this arrangement the separate crosstie heretofore used to support the lower end of the hinge pin is combined with the saddle casting, and the cylinders, frames and saddle are bolted and keyed together to form a strong and rigid structure. The low pressure cylinders are bolted directly to a steel box-casting which is secured to the frames in accordance with the customary practice of the builders.

Similar to the Mallet freight locomotives mentioned above these locomotives are designed to run firebox end first, in order to give the enginemen an unobstructed view of the track. The truck under the firebox, therefore, becomes the leading truck. This truck is of the Hodges type, with spring links so jointed as to allow a fore-and-aft as well as lateral motion. A new design of centering device is applied to this truck. A double coil centering spring is used, and it is held in a vertical position, between two cast steel washers, and is guided by a vertical thrust bar. This thrust bar is placed on the center line of the locomotive and is suspended from a crosstie. Interposed between the top spring washer and the crosstie is a bearing plate. Two pins, each 2 in. in diameter, are placed between the bearing plate and the crosstie, and on these pins is suspended a U-shaped strap, which is wide enough to embrace the spring washers. A link connects the lower end of the strap with a lug which is bolted to the truck frame. When the frame is displaced from its middle position, the strap is pulled to one side, and one of the upper pins is drawn down, thus pushing on the bearing plate and throwing the spring into compression. The bottom spring washer is held in place by a link which is pinned to the engine frame.

These locomotives are equipped for burning oil, and the tenders are coupled at the smoke-box end. The two tanks are semi-cylindrical in shape and are placed end to end. They have respective capacities for 3,200 gallons of oil and 10,000 gallons of water. The tender frame is composed of 12-inch channels weighing 40 pounds per foot, and strongly braced transversely, while the end bumpers are of cast steel. The tender trucks and also the back engine truck, are equipped with forged and rolled steel wheels.

In designing these locomotives, full advantage has been taken of the experience gained with the Mallet freight engines which have been operating for some time on the Central Pacific. Special attention has been given to the steam distribution, and to providing ample sectional areas in the steam and exhaust piping. Although the duty which these locomotives are intended to per-

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GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Oil
Tractive effort	66,000 lbs.
Weight in working order	384,800 lbs.
Weight on drivers	320,100 lbs.
Weight on leading truck	21,000 lbs.
Weight on trailing truck	43,700 lbs.
Weight of engine and tender in working order	568,000 lbs.
Wheel base, rigid	11 ft.
Wheel base, total	51 ft. 4 in.
Wheel base, engine and tender	85 ft. 1 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.85
Total weight ÷ tractive effort	5.83
Tractive effort × diam. drivers ÷ heating surface*	584.20
Total heating surface* ÷ grate area	101.67
Firebox heating surface ÷ total heating surface* %	3.30
Weight on drivers ÷ total heating surface*	45.00
Total weight ÷ total heating surface*	54.00
Volume equivalent simple cylinders, cu. ft	23.56
Total heating surface* ÷ vol. cylinders	302.08
Grate area ÷ vol. cylinders	2.97

CYLINDERS.

Kind	Compound
Diameter and stroke	25 & 38 x 28 in.

VALVES.

Kind	Piston
Diameter	15 in.
Lead	5/16 in.

WHEELS.

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	82 in.
Firebox, length and width	120⅝ x 84 in.
Firebox plates, thickness	⅜ x ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	495-2 in.
Tubes, length	20 ft. 6 in.
Heating surface, tubes	5,292 sq. ft.
Heating surface, firebox	235 sq. ft.
Heating surface, total	5,527 sq. ft.
Feed water heating surface	1,590 sq. ft.
Grate area	70 sq. ft.

TENDER.

Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	10,000 gal.
Oil capacity	3,200 gal.

* Includes feedwater heating surface.

ACCOUNTING BY THE STOREKEEPER

In a very important and interesting paper entitled "The Accounting Department in Connection with the Mechanical and Stores Department"—read before the Canadian Railway Club, A. A. Goodchild, auditor of stores, and mechanical accounts, had the following to say anent the railroad storekeeper and the work of his department:

Let us discuss for a few moments the duties, responsibilities, and qualifications of a storekeeper, and in doing this, we shall deal with only the general practice of roads whose storekeepers are the custodians of unused material. The larger question as to the duties of taking cognizance of all material until actually used may be left to some future consideration.

These duties bring him in constant touch with the entire operating department of a road. Locomotive, car, bridge and building, transportation, and other branches of the service are dependent upon him for supplying the necessary materials with which to carry on the work, whether it be construction of a thousand box cars, or the putting on of a patch to the side of a car, the building of cars, large monster locomotives, or the supplying of a tender truck box cover, wherever we find material being used, there also we find the storekeeper an interested party, and this interest entails upon him the need of cultivating a very close acquaintance with the heads, and the requirements of the various departments. He is above all also an operating official, and should be able at all times to supply the material needs of the entire railroad. These needs are varied. No line of business can be excluded from its voracious maw. Hardware, glass, oils, paints, drugs, acids. The precious metals, lumber from the cheapest to the most expensive, minerals, coals, coke, road and shop tools of every description, office supplies, flour, cement, silks, furniture, carpets, and so on, *ad lib,* all serve to appease, but never satisfy the hunger of our railroad systems.

What kind of a man is required to cater to all these varied needs, and to cater intelligently, in order that he may furnish the maximum amount of satisfaction at a minimum expense to his employers; be ever ready to fill the orders and never overload himself with material which the aesthetic taste of a superintendent of motive power, or a master car builder refuses to attempt to digest? Surely a man to fulfil such requirements must be a paragon, surely such duties in themselves entail a large enough field for the most industrious cultivation, and the requisitioning for, receiving, storing, and disbursement of such material, calls for the very highest ability taxed to its utmost capacity. Having those requirements in mind, let us glance briefly at the various steps one must tread before he can reach the topmost rung of the storekeeping ladder. Let us enter one of our large stores, and as we pass along we find our man trucking castings or unpacking boxes of various materials, may be, sweeping away refuse. Later on he is found loading material into cars or getting articles down from the shelves, assisting a storeman. He advances steadily, and is, perhaps, given charge of certain divisions or sections of the store house, and in the fulness of time is called upon to assume charge over the entire section or store.

Hitherto, his work has been manual, but now the stock cards and books engage considerable of his attention, for he is required to know the exact condition of his stock to enable him intelligently to place requisitions for the depleted material, he must know what the average monthly consumption is, how far his stock will provide for ordered requirements, what quantity if any he has on order, and whether through some special or irregular condition he is likely to be called upon for more than his normal supply. Thus it has become necessary for him to devote considerable time and attention to book records. This may be, and frequently is, an entirely new experience for him. Coupled to this, under the system which is still largely in vogue, he must devote his attention to the accounts of his store. The debits and credits are impressed upon him as important factors. For this purpose he engages a clerk, if the funds will permit, who does the necessary book work and accounting for him, and in his ignorance of the merest theory of such work, signs statements and records which are put before the management of a railroad.

It is general practice when a storekeeper keeps his own accounts, for him to keep those of the mechanical department also, the stores being very closely allied thereto, especially in a large plant where considerable manufacturing is carried on for road purposes. This necessitates his becoming a timekeeper, as the largest disbursements of mechanical accounts are for labor. He must become an authority on distribution of such labor and exercise a prerogative in connection with shop system, contract work, etc. Is it not hopeless to expect a man with a training which I have briefly outlined, to meet such varied requirements? With all respects to the large number of able general storekeepers on this continent, I affirm that they cannot devote their attention to storekeeping, accounting, and shop systems, with justice to either branch of the work. Indeed, there is very little, if any, attempt at doing this, as a matter of fact. It is largely a fiction. The clerk is held responsible for statements, etc., issued under a storekeeper's signature for the reason that the storekeeper himself has no time to attend to such matters, and not infrequently looks upon them as of very secondary importance, or is lacking in a proper appreciation of the value of such duties, and he almost naturally develops a tendency to protect the stores account at the expense of those of the mechanical department. Quite apart from the question of integrity of the departmental officials, a feeling of dissatisfaction inevitably underlies all questions of disputed costs.

Speaking from experience I have no hesitation in affirming that it is a simple matter to load an account with items which should never be charged thereto, and to so manipulate accounts as to afford more than ample protection to the storekeeping department. There was a time in the recollection of many, when the necessity for proper accounting methods and men was not realized as it is to-day. Everything pertaining to the accounts, from the man who "wanted to know" to the underpaid clerk who was expected to "show," was accorded very little consideration, and one can almost understand how it came about that the storekeeper was looked upon as a sufficiently informed and responsible person to take charge of accounting and timekeeping, but to-day, and I venture to say, never more than to-day, it is considered proper and necessary for this work to be handled by men whose minds have been thoroughly trained thereto.

Mr. Goodchild closed his paper with a very strong plea for the accounting of the stores department to be under the direc-

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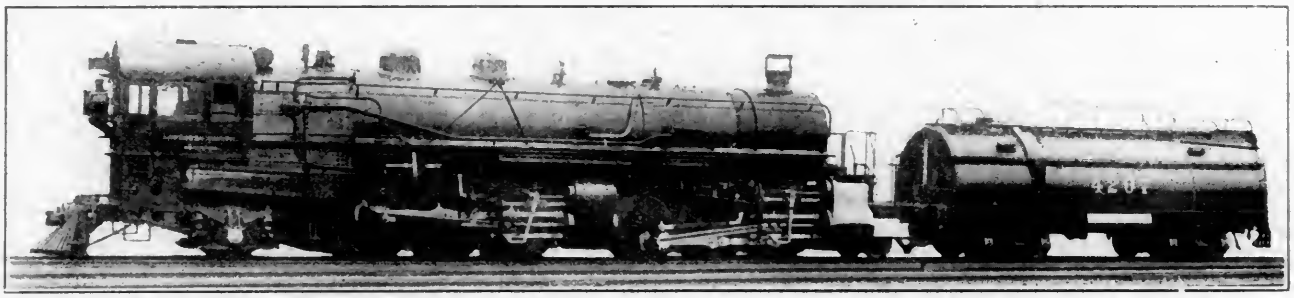

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It is general practice when a storekeeper keeps his own accounts, for him to keep those of the mechanical department also, the stores being very closely allied thereto, especially in a large plant where considerable manufacturing is carried on for road purposes. This necessitates his becoming a timekeeper, as the largest disbursements of mechanical accounts are for labor. He must become an authority on distribution of such labor and exercise a prerogative in connection with shop system, contract work, etc. Is it not hopeless to expect a man with a training which I have briefly outlined, to meet such varied requirements? With all respects to the large number of able general storekeepers on this continent, I affirm that they cannot devote their attention to storekeeping, accounting, and shop systems, with justice to either branch of the work. Indeed, there is very little, if any, attempt at doing this, as a matter of fact. It is largely a fiction. The clerk is held responsible for statements, etc., issued under a storekeeper's signature for the reason that the storekeeper himself has no time to attend to such matters, and not infrequently looks upon them as of very secondary importance, or is lacking in a proper appreciation of the value of such duties, and he almost naturally develops a tendency to protect the stores account at the expense of those of the mechanical department. Quite apart from the question of integrity of the departmental officials, a feeling of dissatisfaction inevitably underlies all questions of disputed costs.

Speaking from experience I have no hesitation in affirming that it is a simple matter to load an account with items which should never be charged thereto, and to so manipulate accounts as to afford more than ample protection to the storekeeping department. There was a time in the recollection of many, when the necessity for proper accounting methods and men was not realized as it is to-day. Everything pertaining to the accounts, from the man who "wanted to know" to the underpaid clerk who was expected to "show," was accorded very little consideration, and one can almost understand how it came about that the storekeeper was looked upon as a sufficiently informed and responsible person to take charge of accounting and timekeeping, but to-day, and I venture to say, never more than to-day, it is considered proper and necessary for this work to be handled by men whose minds have been thoroughly trained thereto.

Mr. Goodchild closed his paper with a very strong plea for the accounting of the stores department to be under the direc-

tion of the general staff of accountants. He believes that auditing or accounting by an independent officer should make for real efficiency, and added that speaking for himself he welcomed an outside auditor, who may be authorized to do so, going over the methods and analyzing the principles upon which the work is conducted, showing up any weak spots in order that whatever remedy is found necessary may be applied.

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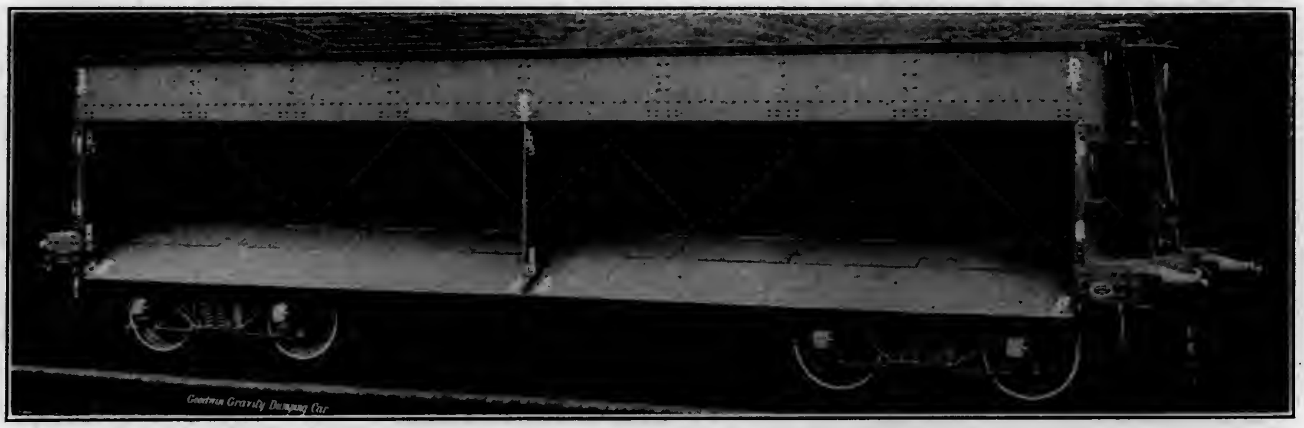

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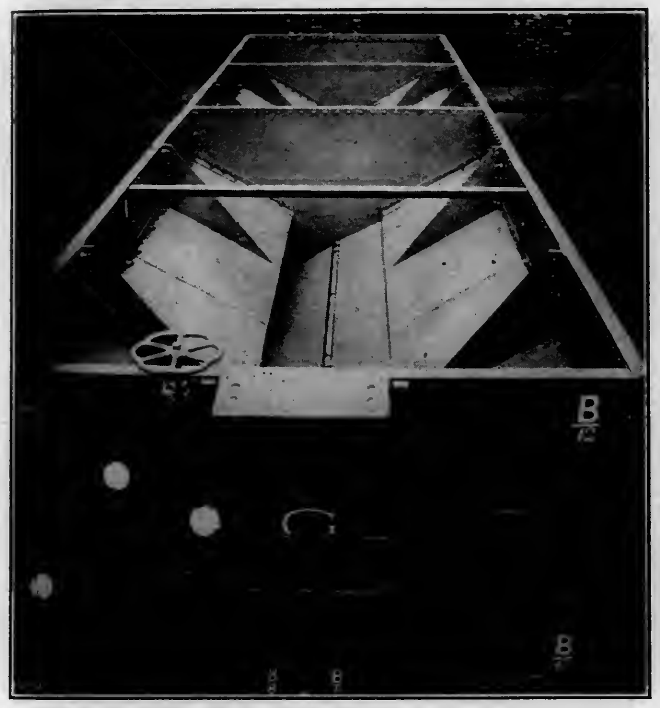

AFTER DISCHARGING LOAD ON ONE SIDE.

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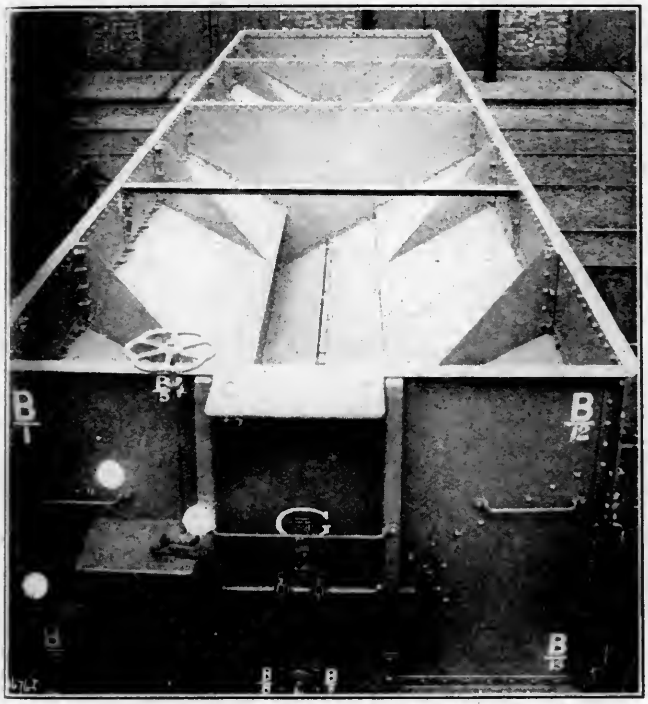

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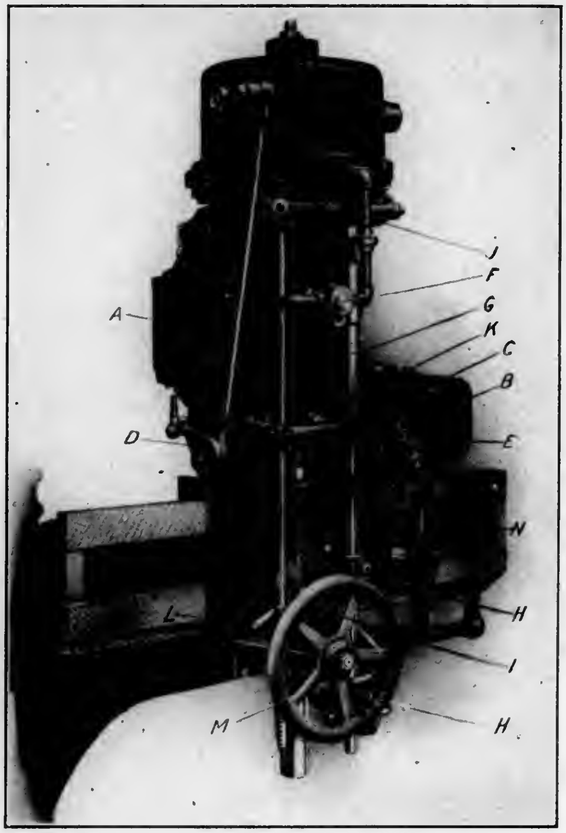
RECENT DEVELOPMENTS IN DRILLING MACHINES

Attendants at the last railway mechanical conventions will remember the exhibit of The Walter H. Foster Co., in Machinery Hall, where there were shown in operation two drilling machines constructed on entirely new principles, one being a radial and the other a multiple spindle machine. The radial drill is of the hydro-pneumatic type and differs entirely in its driving and feeding arrangement from the usual design. The multiple spindle-drill is of the all-geared type, eliminating the use of universal joints. Both of these machines are illustrated herewith.

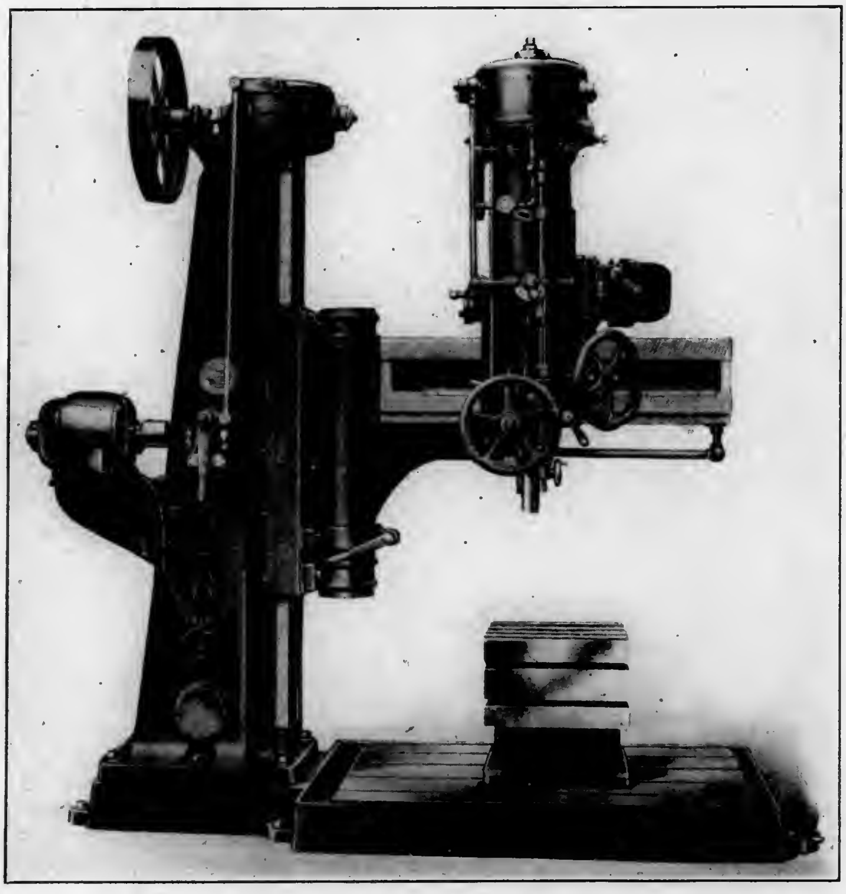
Hydro-Pneumatic Radial Drill.

In this design the complete driving and feeding mechanism is confined to the saddle on the arm and the arrangement is such that the two operations are entirely independent, the rotating of the drill being obtained through a geared connection to an electric motor, while the power for feeding is furnished by air pressure. The remainder of the machine is very largely of usual construction, a small motor being provided on the column for raising and lowering the arm. This motor also drives the oil pump for the lubricant.

Briefly, the construction of the operating mechanism consists of a cylinder, forming part of the saddle, around which is cast a concentric chamber of a capacity practically equal to that of the cylinder. Above this is a gear box, through which the motor drives the spindle—the arrangement being for two different spindle speeds for each motor speed. The motor is of the direct current variable speed type and the controller with its resistance is mounted at a convenient location on the cylinder. The spindle passes continuously through the center of the cylinder to the gear box at the top. The piston in the cylinder has a loose fit on the spindle and ball bearing collars are provided above and below it, so that all vertical movement of the piston is communicated to the spindle, but the rotating of the latter does not affect the former. Air pressure from the shop line, which should not be less than 80 lbs. per square inch, is admitted to the cylinder above the piston and furnishes the power for feeding the drill. Below the piston the cylinder is filled with oil and communication provided through a properly designed valve between the cylinder and the surrounding chamber. After the spindle has reached the end of its stroke the air pressure is transferred from the cylinder to the top of the oil in the chamber, thus forcing it back into the cylinder and pushing the piston with the spindle to the top. It will be seen that any desired rate of feed can be obtained by the proper throttling of the oil in its passage from the cylinder and also that a remarkably steady feed can be obtained with the elimination of all back lash with its danger of breakage of drills under such conditions as striking a hard spot or breaking through at the finish of a hole. In case the feeding resistance becomes greater than the total air pressure the spindle will simply revolve and do no damage. An automatic device is provided for shutting off the air pressure at any desired point and automatically returning the spindle.



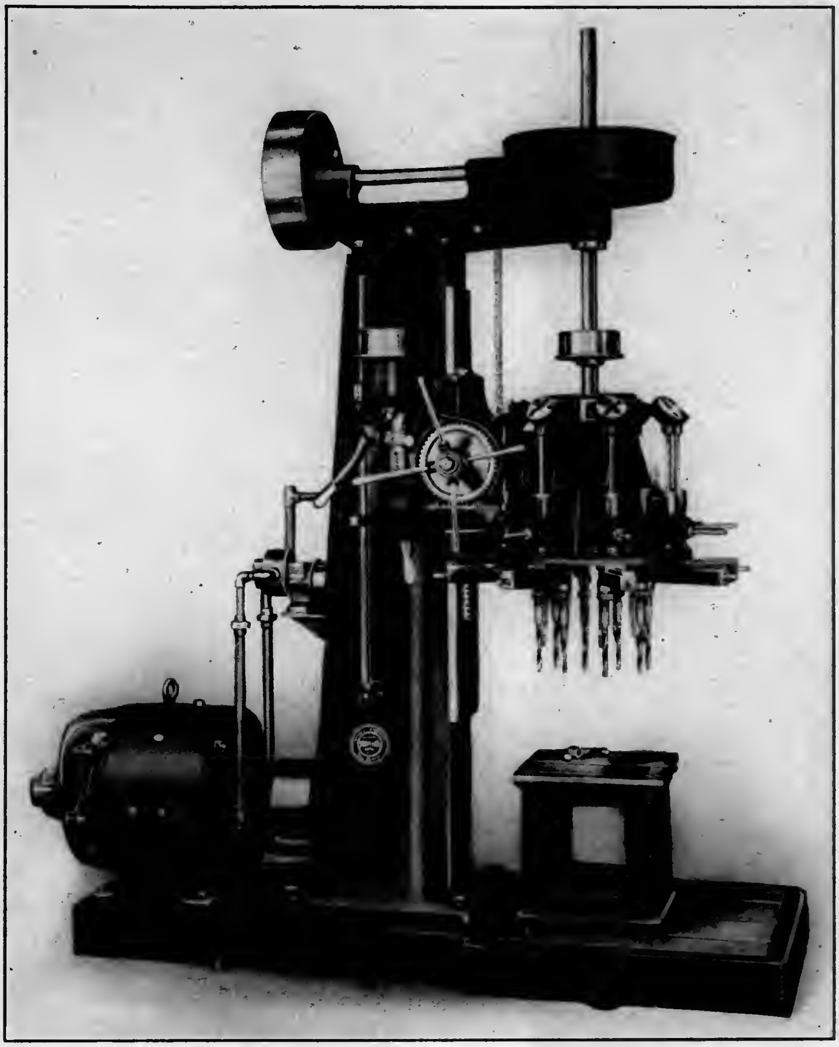
DETAIL VIEW OF THE OPERATING MECHANISM.


HYDRO-PNEUMATIC RADIAL DRILL.

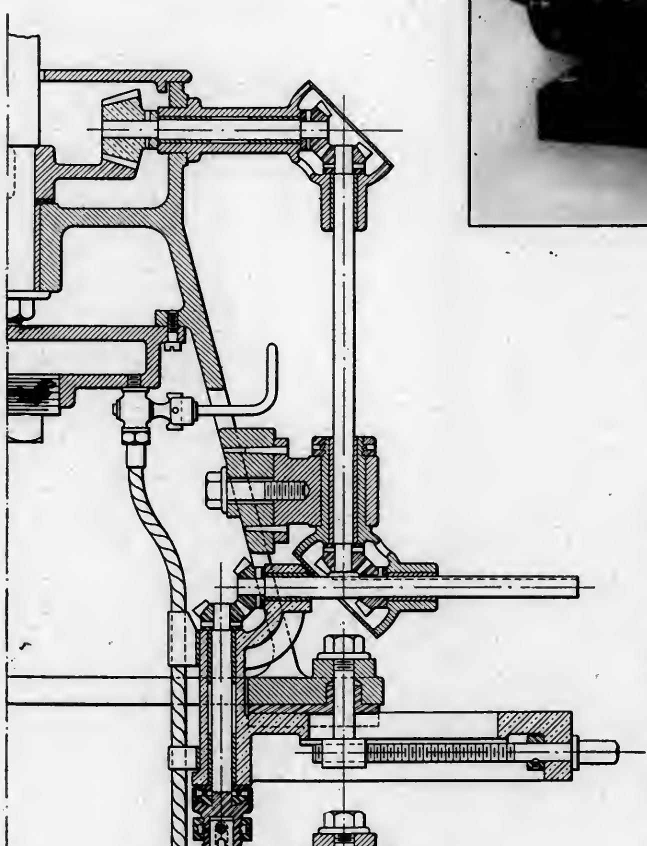
In the enlarged view of the head the arrangement and construction is shown very clearly. The motor is shown at *A* and the controller of the drum type having ten points of contact, is indicated by *B*. The resistance *C* is attached in a very handy and compact form back of the controller. Lever *D* operates the clutch for the high and low speed gears in the gear box at the top of the cylinder. Feed operating valve

E has a flat seat and controls the passage of oil from the cylinder to the surrounding chamber and valve *F* controls the passage of the air either to the cylinder or to the surrounding chamber. This is a four-way valve opening an exhaust from one side to the other, as desired. Vertical shaft *G* operates this valve and is provided with adjustable trip dogs *H* arranged to swing out of the way when the spindle is operated by hand. *I* is a tappet on the spindle for striking the dogs on the shaft *G*. Valves *J* and *K* operated by lever *L* permit the air and oil to pass freely in either direction and are used when the spindle is operated by hand, this hand operation being performed by means of wheel *M*. The hand wheel *N* is for moving the head in and out on the arm.

The manufacturers state that the efficiency of this drill is best indicated by the size of motor needed to do the same work when compared with a geared radial drill of the same size. On a geared radial it is stated that to drive the friction load at 330 r. p. m. requires 3.5 h.p., while on the hydro-pneumatic drill under the same condition but .8 h.p. is needed. The working load on a geared drill, using a 1 in. drill, 338 r. p. m., .022 in. feed per revolution of spindle, drilling 7.4 ins. per minute, is equivalent to 30 h.p., while the working load of a hydro-pneumatic drill with the same speed and feeds is but 8 h.p. These drills are now furnished in two sizes, 4 ft. and 6 ft., and it is expected that other sizes will be manufactured later.



ALL-GEARED MULTIPLE SPINDLE DRILL.



SECTIONAL VIEW OF ALL-GEARED MULTIPLE SPINDLE DRILL.

All-Geared Multiple Spindle Drill.

To obtain the same high efficiency in production with a multiple spindle drill that is given by other high speed drilling machines is the object of the new all-geared design exhibited which is shown in the accompanying illustration.

It has been found that the extremely tough high grade alloy steels entering into the construction of automobiles and other high grade work are not capable of being machined in as efficient a manner on the multiple spindle drilling machines in use and at the same time allow the full benefit of the high speed drills to be obtained. These machines were of the universal joint principle, and it was believed that too large a proportion of the power was being consumed at this point, and therefore a design was drawn up which uses gears only. This drill has proved its ability to use high speed steel drills to their full capacity in this class of work.

The machine is so designed that the spindles, of which there can be any desired number from four to sixteen (the machine shown has eight), can be set to drill any lay-out desired within its range, whether circular, square, rectangular, or in a straight line, or in fact any shape needed. The sectional drawing, through one of the spindles, together with the general view of the machine, clearly illustrates how the different adjustments of the spindles are obtained. The whole driving apparatus, connected to the main vertical shaft, is mounted in a steel casting carried in

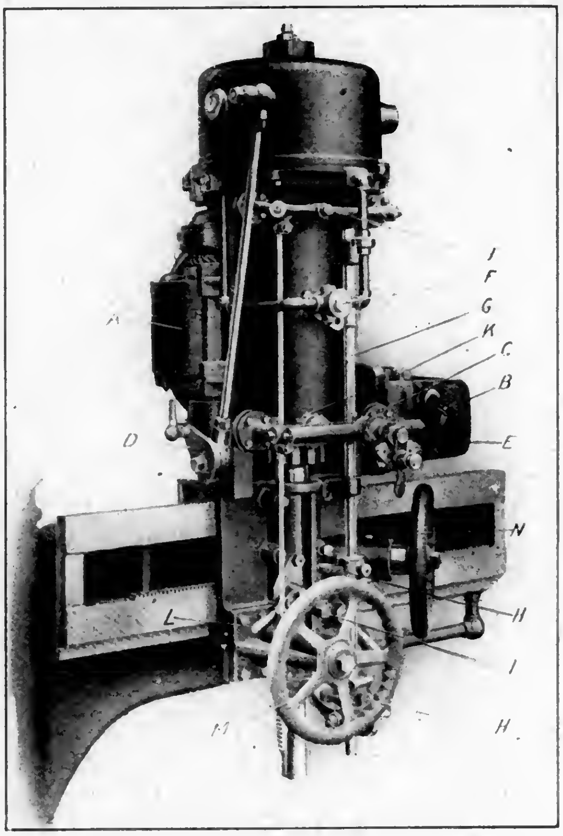
RECENT DEVELOPMENTS IN DRILLING MACHINES

Attendants at the last railway mechanical conventions will remember the exhibit of The Walter H. Foster Co., in Machinery Hall, where there were shown in operation two drilling machines constructed on entirely new principles, one being a radial and the other a multiple spindle machine. The radial drill is of the hydro-pneumatic type and differs entirely in its driving and feeding arrangement from the usual design. The multiple spindle drill is of the all-geared type, eliminating the use of universal joints. Both of these machines are illustrated herewith.

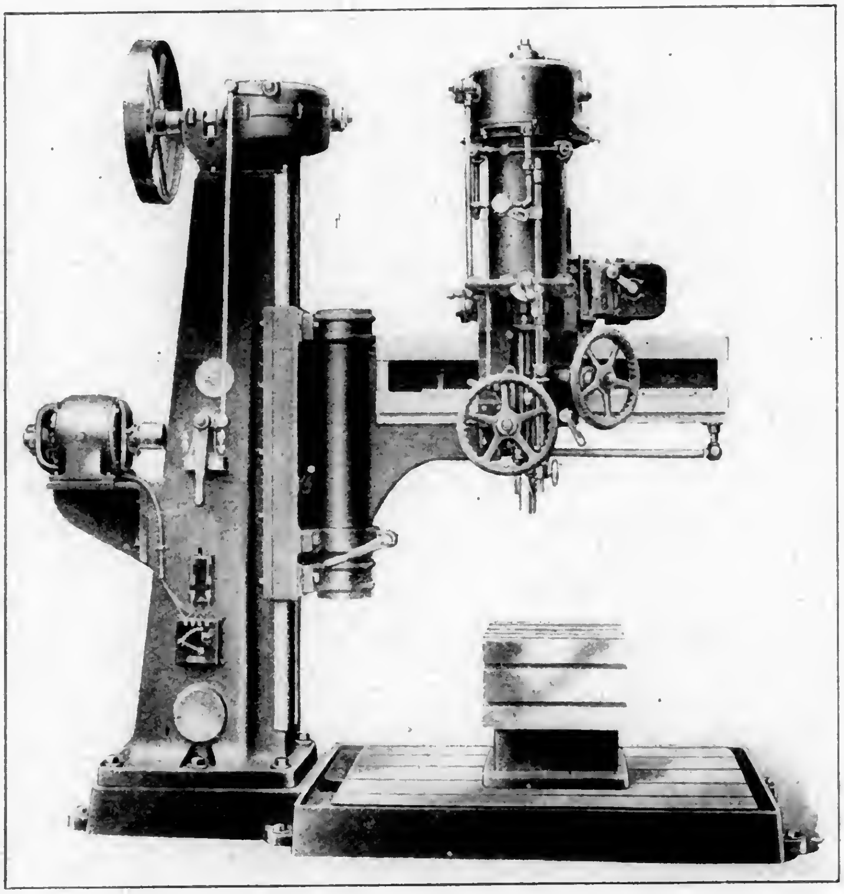
Hydro-Pneumatic Radial Drill.

In this design the complete driving and feeding mechanism is confined to the saddle on the arm and the arrangement is such that the two operations are entirely independent, the rotating of the drill being obtained through a geared connection to an electric motor, while the power for feeding is furnished by air pressure. The remainder of the machine is very largely of usual construction, a small motor being provided on the column for raising and lowering the arm. This motor also drives the oil pump for the lubricant.

Briefly, the construction of the operating mechanism consists of a cylinder, forming part of the saddle, around which is cast a concentric chamber of a capacity practically equal to that of the cylinder. Above this is a gear box, through which the motor drives the spindle—the arrangement being for two different spindle speeds for each motor speed. The motor is of the direct current variable speed type and the controller with its resistance is mounted at a convenient location on the cylinder. The spindle passes continuously through the center of the cylinder to the gear box at the top. The piston in the cylinder has a loose fit on the spindle and ball bearing collars are provided above and below it, so that all vertical movement of the piston is communicated to the spindle, but the rotating of the latter does not affect the former. Air pressure from the shop line, which should not be less than 80 lbs. per square inch, is admitted to the cylinder above the piston and furnishes the power for feeding the drill. Below the piston the cylinder is filled with oil and communication provided through a properly designed valve between the cylinder and the surrounding chamber. After the spindle has reached the end of its stroke the air pressure is transferred from the cylinder to the top of the oil in the chamber, thus forcing it back into the cylinder and pushing the piston with the spindle to the top. It will be seen that any desired rate of feed can be obtained by the proper throttling of the oil in its passage from the cylinder and also that a remarkably steady feed can be obtained with the elimination of all back lash with its danger of breakage of drills under such conditions as striking a hard spot or breaking through at the finish of a hole. In case the feeding resistance becomes greater than the total air pressure the spindle will simply revolve and do no damage. An automatic device is provided for shutting off the air pressure at any desired point and automatically returning the spindle.



DETAIL VIEW OF THE OPERATING MECHANISM.

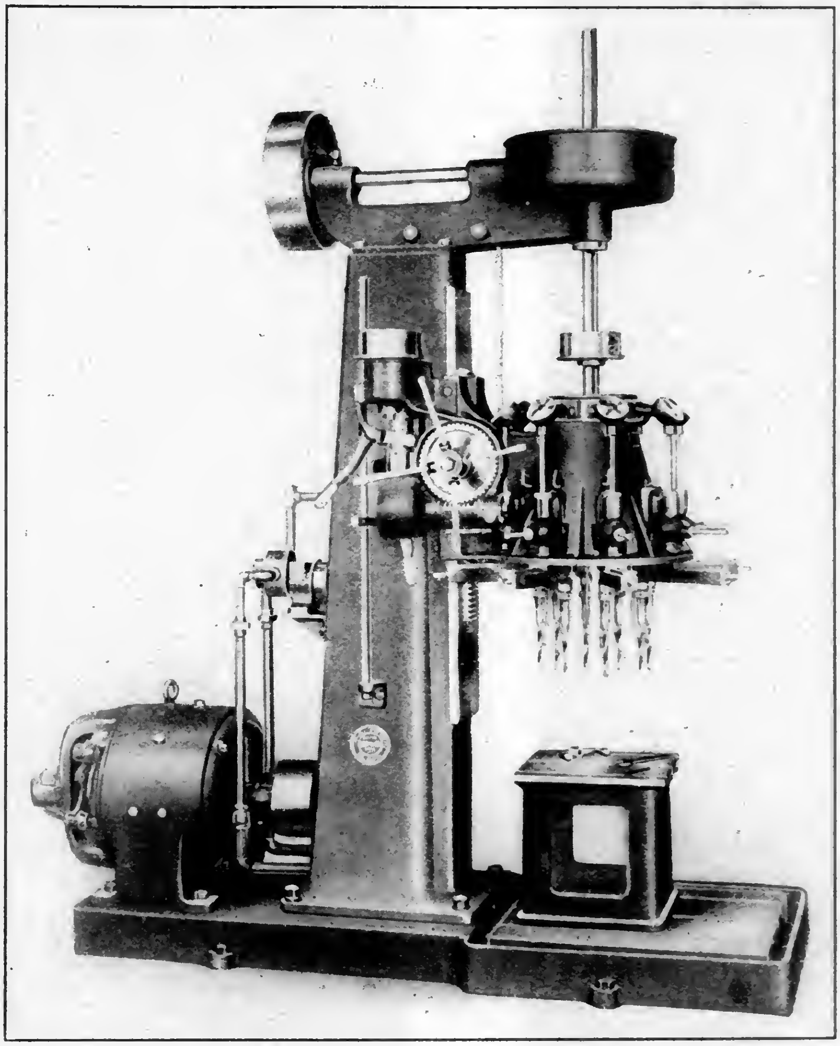


HYDRO-PNEUMATIC RADIAL DRILL.

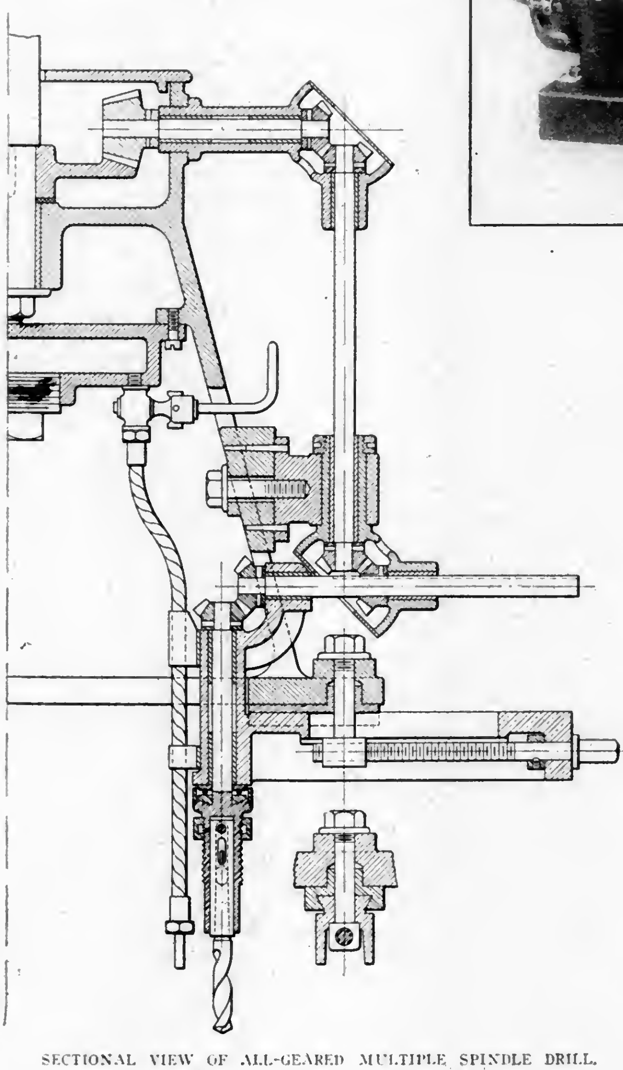
In the enlarged view of the head the arrangement and construction is shown very clearly. The motor is shown at *A* and the controller of the drum type having ten points of contact, is indicated by *B*. The resistance *C* is attached in a very handy and compact form back of the controller. Lever *D* operates the clutch for the high and low speed gears in the gear box at the top of the cylinder. Feed operating valve

E has a flat seat and controls the passage of oil from the cylinder to the surrounding chamber and valve *F* controls the passage of the air either to the cylinder or to the surrounding chamber. This is a four-way valve opening an exhaust from one side to the other, as desired. Vertical shaft *G* operates this valve and is provided with adjustable trip dogs *H* arranged to swing out of the way when the spindle is operated by hand. *I* is a tappet on the spindle for striking the dogs on the shaft *G*. Valves *J* and *K* operated by lever *L* permit the air and oil to pass freely in either direction and are used when the spindle is operated by hand, this hand operation being performed by means of wheel *M*. The hand wheel *N* is for moving the head in and out on the arm.

The manufacturers state that the efficiency of this drill is best indicated by the size of motor needed to do the same work when compared with a geared radial drill of the same size. On a geared radial it is stated that to drive the friction load at 330 r. p. m. requires 3.5 h.p., while on the hydro-pneumatic drill under the same condition but .8 h.p. is needed. The working load on a geared drill, using a 1 in. drill, 338 r. p. m., .022 in. feed per revolution of spindle, drilling 7.4 ins. per minute, is equivalent to 30 h.p., while the working load of a hydro-pneumatic drill with the same speed and feeds is but 8 h.p. These drills are now furnished in two sizes, 4 ft. and 6 ft., and it is expected that other sizes will be manufactured later.



ALL-GEARED MULTIPLE SPINDLE DRILL.



SECTIONAL VIEW OF ALL-GEARED MULTIPLE SPINDLE DRILL.

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guides on the column and the feeding mechanism is located at that point. The weight of the head is counterbalanced by a weight inside the column. Arrangements are made for three different rates of feed for each drill spindle speed. All the gears throughout the machine are of steel or bronze hardened where necessary and all bearings are bronzed bushed. The spindles are

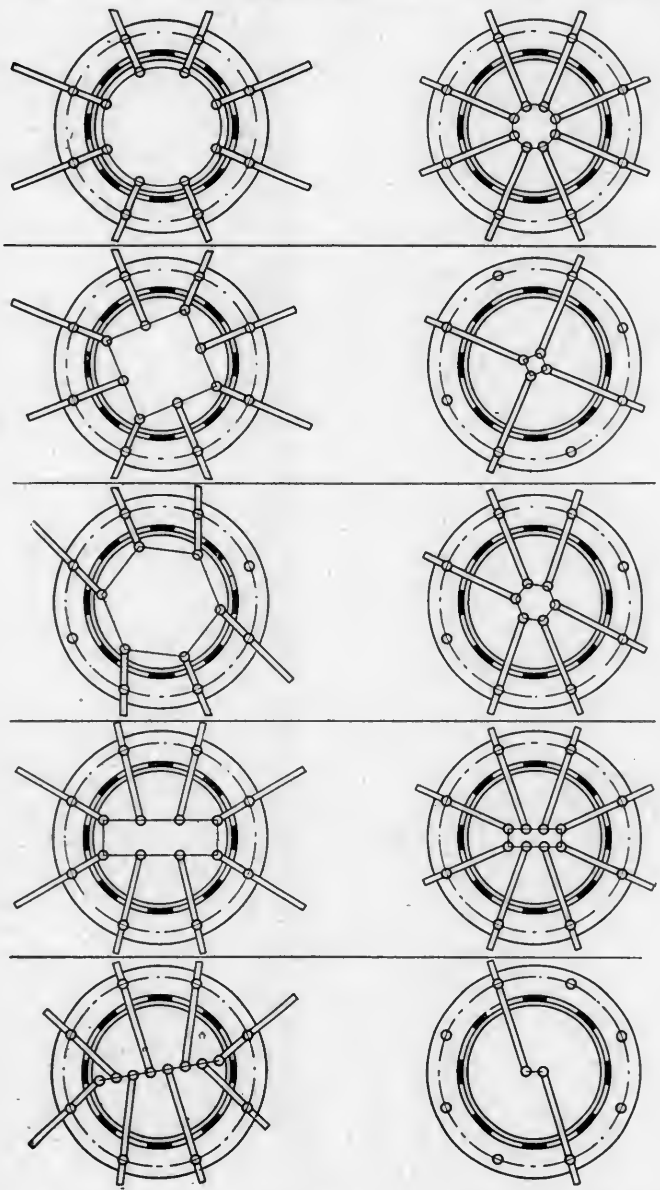

DIAGRAM SHOWING RANGE OF WORK ON MULTIPLE SPINDLE DRILL.

provided with ball thrust bearings and each spindle has an individual oiling arrangement through a flexible tube. The motor is mounted on the base of the machine and drives through a belt. An oil pump with circulating pipes and automatic relief valve is also provided.

Grand Trunk Pacific Extensions.—The Grand Trunk Pacific is spending $17,000,000 this year in constructing some thousand miles of new track. It is stated that 10,000 men and 4,000 teams have been engaged. There is keen competition between the Grand Trunk Pacific and the Canadian Northern as to which will first reach the Pacific Coast. Up to the present the grade on the main line has been carried almost to Tete Jaune Cache, a point about 1,100 miles west of Winnipeg, while steel has actually been laid as far as Fiddle Creek, about 80 miles east of Tete Jaune Cache.

CONDITION OF WOODS BOILER AFTER THREE YEARS SERVICE

Three locomotives fitted with Woods firebox and tube plates were put into service on the New York Central lines on Dec. 4, 1908, and have been on regular passenger runs since that time. One now has its third set of flues and on going to the shop recently was given a very careful external and internal inspection by C. J. Chester and Mr. Hennessey, the New York Central superintendent of the boiler department, Depew shops, as well as by Edward Oldman, boiler maker for Farrar & Trefts, who made the boilers, and Fred H. Snell, inspector for Mr. Wood.

The general condition of the boiler was conceded to be much the same as when examined internally October, 1910. The corrugation of firebox forming side and crown was examined very carefully and found free from any defects. It was noted the crown staybolts showed having sweated after dumping of fires. It was found that more effective washouts might have kept crown sheet much freer from cake scale, same as the sides of the firebox which were clean. The back tube plate was examined carefully and tube holes were found round and in good form, not distorted—no cracks between bridges of tubes.

The corrugations on the back tube plate encircling the tubes were carefully examined by the gauges from which they were made and the center bottom was affected by expanding tubes, closing it inward from its shape as much as 3/16 of an inch. This with working under expansion and contraction had caused an extension strain which showed a tendency to crack. There were one or two places in this part where a penknife blade might be inserted 3/16 in., and to the right a line 33 in., to the left one 34 in., no part of which was 1/64 in. deep. This crack part referred to can be fixed by the Oxy-Acetylene welder, therefore it was not considered these would in any way interfere with the working of the boiler until another set of flues are put in, when the same examination can be made again. No cracks were found between bridges of flues or on any part of the back flue sheet except those above mentioned.

From a careful staybolt test it was found that two throat sheet staybolts were broken, one on left first row under radius of throat sheet, and one right, also one stay on each side of firebox at throat sheet end, about at the bottom of radius of firebox crown sheet, also one in right corner of back sheet, and four in third row over center of fire doors on back sheet of firebox. These are the only staybolts to be replaced since last shopping. The mud ring was examined and found tight and in first-classs condition, as well as staybolts on outside, which showed no appearance of leaking on outside wrapper sheet, nor did the rivets of the boiler shell.

The front tube sheet was found in perfect shape with good flue holes and no cracked bridges, the corrugation corresponding with the gauges.

The United States Leads the World in telephonic communication, there being one telephone for every twelve and one-half inhabitants in the country. Canada ranks second and Sweden third, on this basis. It is also an interesting fact that New York City alone has as many telephones as Germany. Ohio has as many as Great Britain; Chicago more than London, while Boston has double the number of telephones in Paris. In all of Europe with its twenty-six countries there are only one-third as many telephones as in the United States.

Mileage of Chinese Railroads.—There are more than 4,150 miles of railroad in operation in China, and of that mileage the Chinese have 1,128 miles, and in combination with British capital 708 miles more. The Russians built 1,088 miles in Chinese territory when they counted upon making Manchuria a part of the Russian empire. The capital for the remaining road came from Great Britain, Germany, France, Japan, Belgium and the United States—thirty miles being the meager American share.

FRAME WELDING AND REPAIRING

At the Nineteenth Annual Convention of the International Railroad Master Blacksmiths' Association held in Toledo, O., July 15-17, a number of excellent papers were read and were discussed with the same animated spirit which has always characterized the meetings of this body. The various timely questions of tools and formers, drop forgings, flue welding, frame welding, case hardening or carbonizing, piece work, spring making and repairs, high speed steel, and special welding and threading steel were presented in turn, and their consideration has added many valuable items to existing information.

The subject of frame welding is probably of greater interest at this time and the views of J. G. Jordan (T. & N. O.) may be regarded as of some significance. Mr. Jordan said in part as follows:

Repairing frames of engines in roundhouses is a makeshift job, and always will be. You cannot get stock enough in each end of the weld, and the frames will waste away in making your heat, no matter what you heat with—gas, oil or thermit,

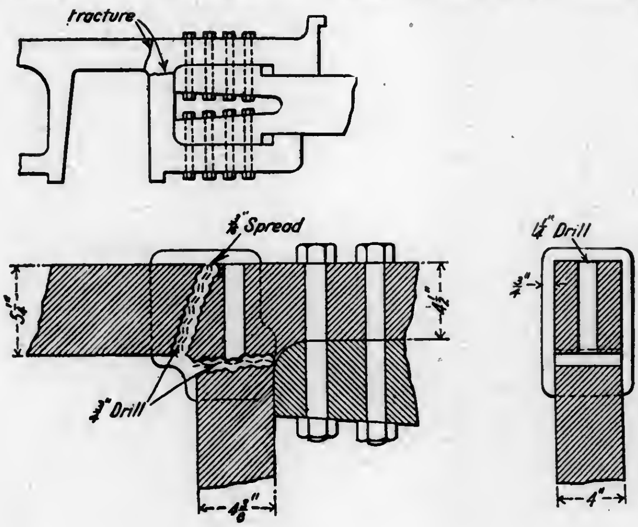

FIG. 1.

but we have to weld them in the roundhouse to keep the engines in service. At present we are welding with thermit. I think it is the best temporary job you can make. A molder is broken in for this class of work, and he makes his own mold and does all his own work, except when taking off the heat, at which time he is assisted by a helper. Of course, there are many cases where the frames cannot be welded in the roundhouse; when they break under or near the firebox or under the cylinders. In repairing frames on the anvil we always make the "V" so that the grain of the iron is parallel with the frame, and we use good iron and coal, a good heater and plenty of stock.

Objection was taken to Mr. Jordan's statement that welds made with the frame in place were makeshifts. If the proper precautions are taken there are no good reasons why such welds should not be a success. If is, of course, less convenient and more difficult than working on an anvil, but it is far more satisfactory from the standpoint of cost—both for the actual work done, and the time of keeping the engine out of service. It is not necessary to use collars with the thermit weld. If the frame is properly heated before welding with thermit there should be no trouble in getting successful results.

In this connection G. W. Kelly (C. R. R. of N. J.) said that thermit was used by him in making repairs to frames under the engine. The accompanying sketch, Fig. 1, illustrates a difficult compound weld which was made recently in the roundhouse at Elizabethport, N. J. The 1¼ in. hole is drilled through the top rail to give the thermit a better opportunity to circulate, and to permit the frame to preheat more uniformly. The pedestal jaw was spread apart 3/16 in. Formerly, when the leg was broken from the top rail of the frame these welds gave trouble and two or three failures resulted, but since the 1¼ in. hole has been used through the frame into the break, allowing the thermit to circulate around the frame and through the hole, there have been no failures. Mr. Kelly commented further as follows:

To prevent the frame from upsetting while preheating and welding, we expand the opposite frame with a slow charcoal fire. When a frame is broken in two or more places in the front pedestal and the engine requires general repairs the broken pedestal is replaced by a steel one which is already machined.

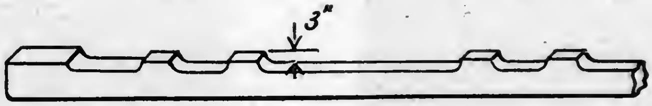

FIG. 2.

Some of these require three welds, as this type of pedestal is welded to the front end of the frame forward of the guide-yoke, thus cutting out the splice and making a continuous frame.

The writer has been asked: "Do you consider thermit welding permanent, and will the weld hold during the life of the engine?" Since August, 1906, we have made 186 welds on four different classes of engines where it was necessary to apply new steel front pedestals. Of the above welds we have had but one failure, which was due to unequal contraction. During the last six years we have made many welds at various places on steel and wrought iron frames, driving wheel centers, and steel braces, etc., which have given us no trouble. We have found it very beneficial to keep a record of the welds made and the conditions at the time of making them, so that should a failure occur, by looking up the record we can generally locate the reason.

H. D. Wright (Big Four) presented a very interesting contribution on the general subject of both frame repairing and making, saying in part:

In making a frame the frame is blocked out ready for the limbs and braces to be welded in place, as shown in Fig. 2. The lugs should not exceed 3 in. in height, and by this method you will avoid having any cross-grained iron in the frame legs when the limbs are welded on. Fig. 3 shows how the limbs should be forged and scarfed ready to weld on to the frame back. The boss that is left on the limb for the braces should not exceed 2½ in. in height. Before these parts leave the forging hammer, they should be scarfed to an angle of 45 deg. by the use of a V-block and fuller. Then weld the limbs to the frame back in one heat. I prefer to put the frame leg on in one heat, even though the outside scarf does show a little, rather than to have the second heat taken and the center of the iron loosened up by not heating through to the center. It does not do any good to weld up the outside solid and then take it to the planer and plane it all away, and there are certain heats that open a weld very easily when working. For example, take two pieces of 2 in. by ½ in. iron, bring them to a good welding heat and lay them down. You will find it a difficult matter to pull them apart when cold.

Take the same two pieces of iron, if you have not pulled them apart, put them in the furnace and bring them up to a greasy heat and you will not have any trouble in separating

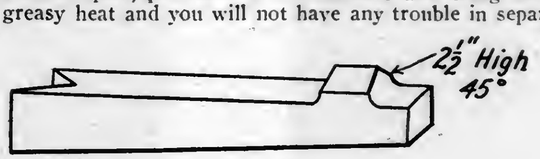

FIG. 3.

them. The same condition is true in frame work, and while you may have trouble to get the men to make a weld in one heat in a day work shop, we have no trouble on this score from men working piece work.

The method of putting in the bracing, commencing at the back end of the frame, is shown in Fig. 4. *A* shows the position of the brace before the hammer makes the weld, and *B* is the finished weld. Cut away the extra metal between the frame brace and back as shown by dotted line with a gouge. This method will make a sound weld, but care should be exercised that the bevel on the frame back has the correct taper, so that when the hammer strikes it, it will be driven into place. The brace *C* is made of two pieces of 4 in. x ⅞ in. iron bolted fast to the back and the holes are spaced the correct distance to allow the brace to slide into place. When the brace is put in place ready for welding it will stand away some distance from the limb; as a rule we put a block of soft wood between the brace and the limb with the grain running the right way so that when the brace begins to draw the block will split, allowing the brace to come back into position.

Fig. 5 shows the lower rail pieces in place. They should be welded first at *A* and *B*, and then at *C* and *D*. By this method you reduce the strains that come on the legs and a few blows of

the hammer on the braces after the weld is made will further remove them. The proper place to strike the braces is indicated by the arrow heads on the sketch. The front end as used on

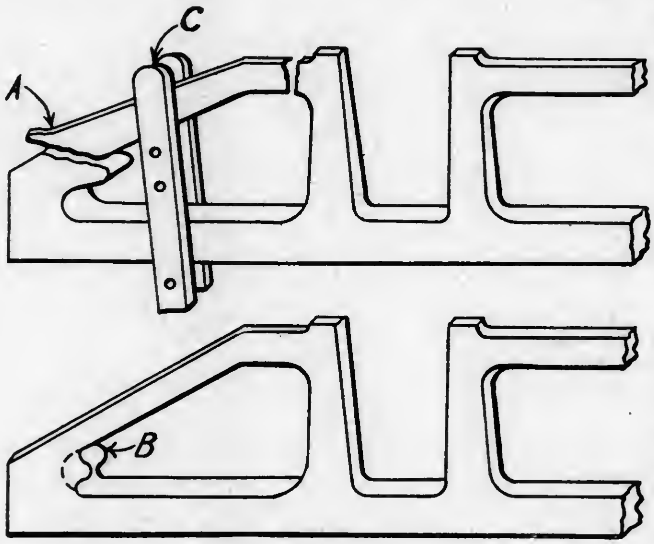

FIG. 4.

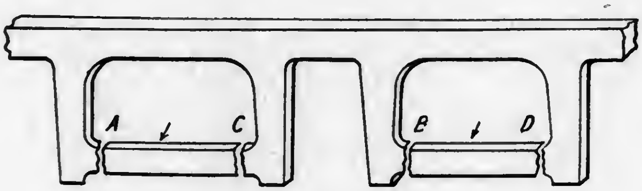

FIG. 5.

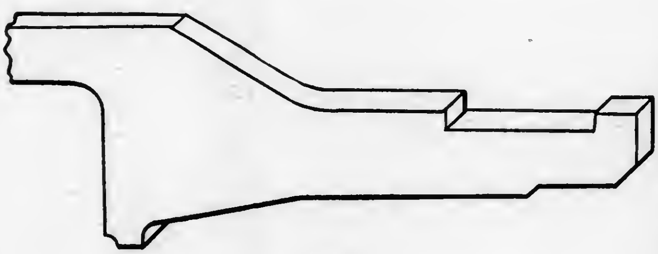

FIG. 6.

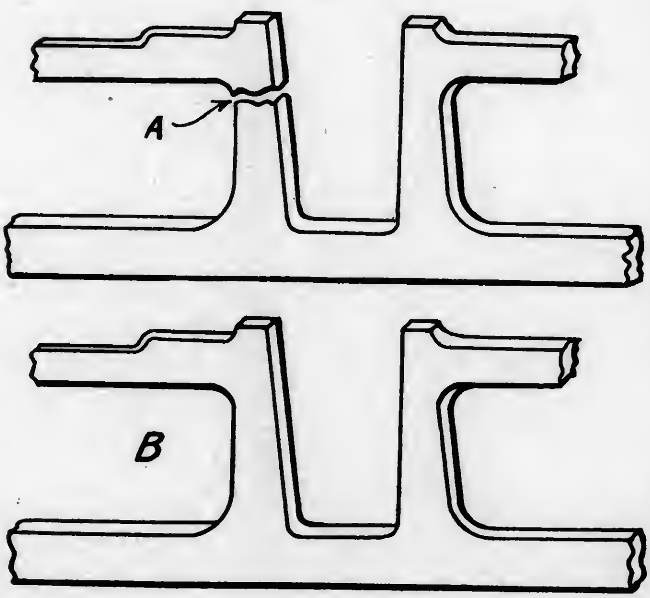

FIG. 7.

some of our heavier engines is made in one piece under the hammer and is shown in Fig. 6. This type of front section is finished in the machine shop and drilled before it is welded to the frame.

The type of front limb that is ordinarily used is shown in Fig. 7, and *A* shows the part ready to weld in place. Weld a small stub on the frame back and then weld on the front limb. In making the offset frame shown in Fig. 8, the back is made in two pieces, and is then welded at *A*, after which the work

FIG. 8.

is handled in the same way as if it were a straight back. In repairing frames, I scarf all my work on a 45 deg. angle. The component forces are thus equal and the wedge will not take any more of the blow than the scarfed frame piece. The parts will thus weld thoroughly from the point to the outside of the frame.

In repairing frames under engines we make all our own preparations and do not call on the machine shop for any help whatever. We have had only one frame that had to be sawed out by a machinist and that was due to the weld being right against the firebox. The type of weld which we use is shown in Fig. 9. In heating the frame member for the purpose of cutting out or welding, we build a brick furnace around the fracture and use fuel oil burners, one on either side. One burner is below the

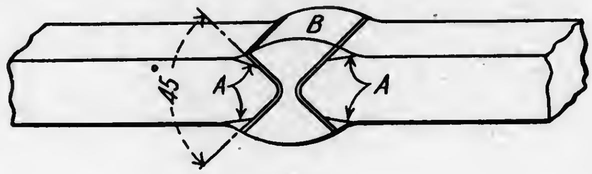

FIG. 9.

fracture and the other above it. This allows the flames to make a circuit around the frame and to heat it up evenly. In building the furnace we always leave two or three bricks on each side so they can be taken out without disturbing the rest of the bricks. This method often saves a great deal of time, for if the weld is not made perfectly on the first heat the bricks can be replaced and another heat taken.

In preparing the frame for welding, we cut it out on a 45 deg. angle and then warm up and spring it apart 5/16 in. or 3/8 in. We then cut in at point *A* and drive in four wedges to bring up the stock to allow for wasting in welding. The large wedge is then made and is driven into place making a tight fit. When the frame is brought to a welding heat the loose bricks are removed from each side of the furnace and the rams are used. I have successfully welded 136 frames under engines in this way during the past three years.

Progress in Steel Car Construction.—At the beginning of this year there were about 3,000 passenger cars in service in this country, built of all-steel construction. The total number of passenger coaches is about 54,600, so that the number of steel cars is about 5.3 per cent. of the total. Of the cars constructed during the present year, 62 per cent. will be all-steel construction, so that at the end of this year fully 9.3 per cent. of all passenger cars will be of steel, while 3.5 per cent. have steel under-frames. The percentage of wooden cars in service has dropped in the last three years from 98.2 to 87.2 per cent.

Another Trans-Andean Railway.—The Argentine Government has just approved of the plans for a narrow gauge line starting from the village of Tinogasta, in the Province of Catamarca and running as far as the Chilian frontier, at San Francisco. The line will cover a distance of 252,743 miles, and the estimated cost is $8,122,460. At San Francisco the line will connect up with the branch line of the Copiapó on the Taltál Railways, both in Chile, thus forming a transandean line.

NEW DESIGN VERTICAL KEYSEAT MILLER

This machine has been developed by the Newton Machine Tool Works, Inc., of Philadelphia, Pa., to displace their former vertical and horizontal spindle machine, the experience of the builders proving conclusively that by use of the special two lip cutter much better time can be made when milling feathered keys of average length. The figures in this connection are interesting, as in ordinary work in the Newton shop the following average rate is maintained: ¼ in. keyseats, 4 in. long, time four minutes and forty-five seconds; ½ in. keyseats, 4 in. long, time four minutes and thirty-five seconds; ⅝ in. keyseats, 4 in. long, time four minutes and thirty-five seconds; 1 in. keyseats, 4 in. long, time seven minutes and ten seconds.

The time here given represents the time required to finish these keyseats after the piece has been clamped in the V-block and includes raising and lowering of the head preparing to shift for another keyseat. The time in seconds represents the time

taken to sink the cutter to the proper depth, eliminating with this process the necessity of drilling clearance holes.

The diameter of spindle is 2½ in. with a double taper on the end, the largest diameter of which is 4¾ in. The spindle is arranged to accommodate cutters with a short No. 4 Morse taper and has drift and retaining key slots. The work table is 11 in. wide over the working surface, and 16½ in. wide over all. The length of the table over the working surface is 6 ft. 10½ in. and 7 ft. 6 in. over all. The minimum distance from the bottom of the spindle to the top of the work table is 6 in. and the maximum distance is 18 in. The spindle speeds with 425 revolutions to the countershaft range from 1,194 to 430 r.p.m. with the back gears out and from 395 to 142 r.p.m. with the back gears in. There are nine changes of gear feed ranging from .115 in. to 10.09 in. per minute. The machine, when belt driven, is furnished with a cone having steps 9 in., 11 in., 13 in. and 15 in. in diameter and each 2¾ in. face. The machine occupies a floor space over all of 8 ft. 6 in. by 7 ft. As a standard, this machine is furnished with a table 4 ft. in length having an automatic feed in either direction of 36 in., but the particular machine illustrated is arranged to feed 6 ft.

The spindle revolves in bushed bearings, and has provision for taking up wear. It is driven by a runabout belt, either direct or through back gears, and is provided with micrometer measurement. Square lock bearings are provided on the saddle to the upright, and the adjustments are made by taper shoes. The work table is surrounded by an oil pan; the feed is obtained by means of a screw and revolving nut; the table has square lock bearings on the base; adjustment is made by taper shoes and the feed is available in either direction. There are nine changes of feed, hand adjustment and pump, piping and attachments for lubrication are furnished, the tank for which is in the base of the machine.

The V-blocks furnished are fitted with auxiliary parallels to accommodate the varying diameters and one of the blocks is mounted on a taper base to permit of raising it when operating on shafts having different diameters. In this photograph it will be noted the long helical spiral milling cutter supported at the bottom by an auxiliary support. This provision is made to handle elongated slots in shafting for hoisting machinery and particularly for locomotive piston rods, as it has been demonstrated to be a much more rapid and economical method of doing this work. The operation consists of drilling first a hole through the work the width of the keyseat, placing the shafts in the V-block and passing the cutter through to the bottom support when the feed is taken. On piston rods a special vise is furnished, permitting of the elevation of the work to obtain the one angular end.

These machines are in very successful operation and as average practice it may be mentioned that 13/16 in. diameter keyseats, 4 in. long, are being milled at the rate of 13/16 in. per minute. In addition to the work mentioned, a number of these machines are in use in keyseating locomotive axles and are said by the different firms to be the most rapid machines ever used on this work.

There is one particular advantage in sinking the cutter to the full depth, and then taking the feed, and that is that the bottom of the cutter can be made a little larger, insuring correct size and perfect fit at the top of the shaft on the key.

PIECE WORK IN THE BLACKSMITH SHOP

In discussing this subject at the convention of the Master Blacksmiths' Association, Henry Mangeot (C. H. & D., Cincinnati, Ohio) said:

"About 14 years ago only about 1 per cent. of the work in the railway smith shops throughout the country was being done by piece work. This has gradually increased until I think it would be safe to state that there is about 65 per cent. of the work being done on a piece work basis in these shops to-day. It has been demonstrated that not only is the employee benefited, but the employer also. I have in mind a certain shop that had sixteen fires in operation and was scarcely able to keep up with the average output of locomotives. Piece work was installed on a small scale. The men did not seem to exert themselves much harder than before, but they made every move count. It was unnecessary for the foreman to get after a man for taking two heats when one would answer the purpose. It was to the man's advantage to see to that part of the work himself and not make any unnecessary work, for it would decrease his net earnings per day.

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the hammer on the braces after the weld is made will further remove them. The proper place to strike the braces is indicated by the arrow heads on the sketch. The front end as used on some of our heavier engines is made in one piece under the hammer and is shown in Fig. 6. This type of front section is finished in the machine shop and drilled before it is welded to the frame.

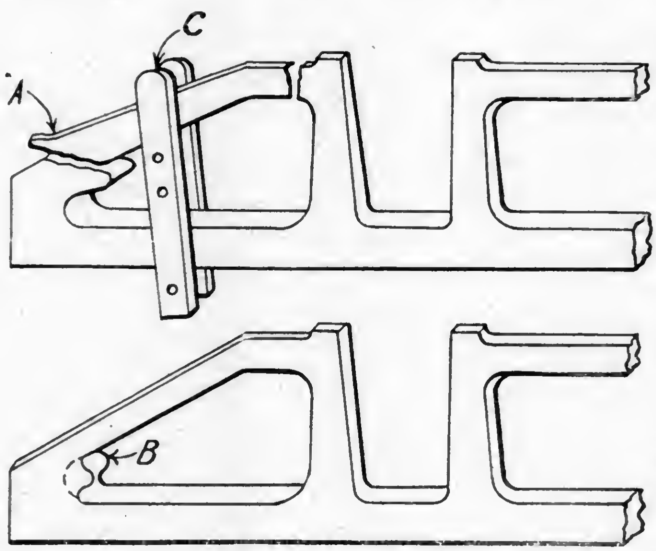


FIG. 4.

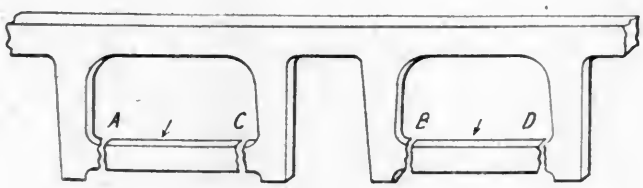


FIG. 5.

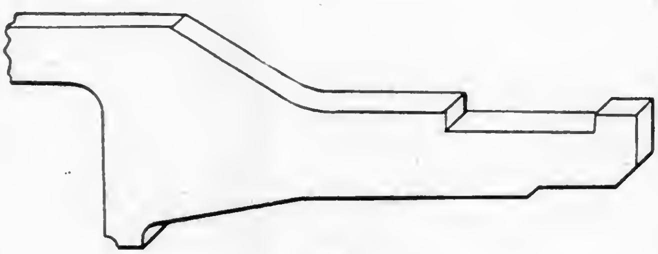


FIG. 6.

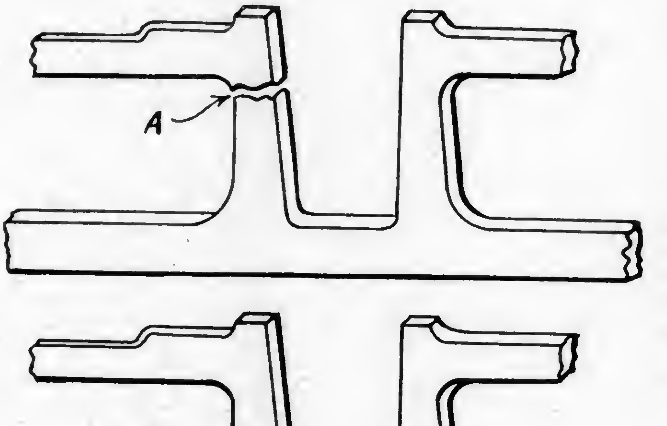


FIG. 7.

The type of front limb that is ordinarily used is shown in Fig. 7, and *A* shows the part ready to weld in place. Weld a small stub on the frame back and then weld on the front limb. In making the offset frame shown in Fig. 8, the back is made in two pieces, and is then welded at *A*, after which the work

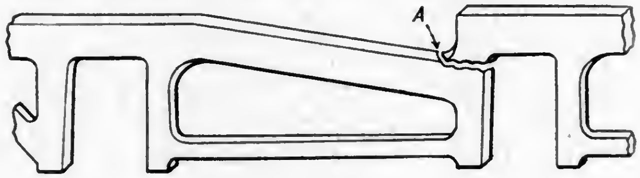


FIG. 8.

is handled in the same way as if it were a straight back. In repairing frames, I scarf all my work on a 45 deg. angle. The component forces are thus equal and the wedge will not take any more of the blow than the scarfed frame piece. The parts will thus weld thoroughly from the point to the outside of the frame.

In repairing frames under engines we make all our own preparations and do not call on the machine shop for any help whatever. We have had only one frame that had to be sawed out by a machinist and that was due to the weld being right against the firebox. The type of weld which we use is shown in Fig. 9. In heating the frame member for the purpose of cutting out or welding, we build a brick furnace around the fracture and use fuel oil burners, one on either side. One burner is below the

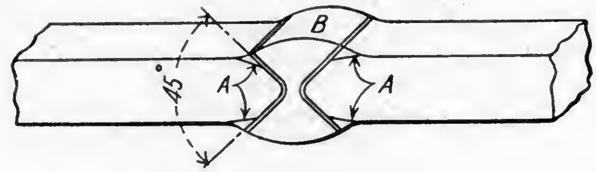


FIG. 9.

fracture and the other above it. This allows the flames to make a circuit around the frame and to heat it up evenly. In building the furnace we always leave two or three bricks on each side so they can be taken out without disturbing the rest of the bricks. This method often saves a great deal of time, for if the weld is not made perfectly on the first heat the bricks can be replaced and another heat taken.

In preparing the frame for welding, we cut it out on a 45 deg. angle and then warm up and spring it apart 5/16 in. or 3/8 in. We then cut in at point *A* and drive in four wedges to bring up the stock to allow for wasting in welding. The large wedge is then made and is driven into place making a tight fit. When the frame is brought to a welding heat the loose bricks are removed from each side of the furnace and the rams are used. I have successfully welded 136 frames under engines in this way during the past three years.

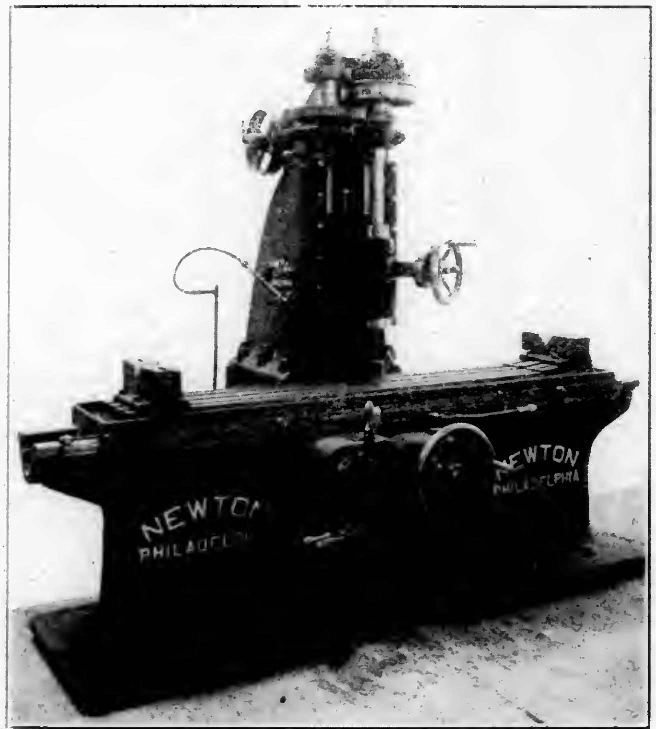
PROGRESS IN STEEL CAR CONSTRUCTION.—At the beginning of this year there were about 3,000 passenger cars in service in this country, built of all-steel construction. The total number of passenger coaches is about 54,600, so that the number of steel cars is about 5.3 per cent. of the total. Of the cars constructed during the present year, 62 per cent. will be all-steel construction, so that at the end of this year fully 9.3 per cent. of all passenger cars will be of steel, while 3.5 per cent. have steel under-frames. The percentage of wooden cars in service has dropped in the last three years from 98.2 to 87.2 per cent.

ANOTHER TRANS-ANDINE RAILWAY.—The Argentine Government has just approved of the plans for a narrow gauge line starting from the village of Tinogasta, in the Province of Catamarca and running as far as the Chilian frontier, at San Francisco. The line will cover a distance of 252,743 miles, and the estimated cost is $8,122,460. At San Francisco the line will connect up with the branch line of the Copiapó on the Taltál Railways, both in Chile, thus forming a transandean line.

NEW DESIGN VERTICAL KEYSEAT MILLER

This machine has been developed by the Newton Machine Tool Works, Inc., of Philadelphia, Pa., to displace their former vertical and horizontal spindle machine, the experience of the builders proving conclusively that by use of the special two lip cutter much better time can be made when milling feathered keys of average length. The figures in this connection are interesting, as in ordinary work in the Newton shop the following average rate is maintained: 1/4 in. keyseats, 4 in. long, time four minutes and forty-five seconds; 1/2 in. keyseats, 4 in. long, time four minutes and thirty-five seconds; 5/8 in. key-seats, 4 in. long, time four minutes and thirty-five seconds; 1 in. keyseats, 4 in. long, time seven minutes and ten seconds.

The time here given represents the time required to finish these keyseats after the piece has been clamped in the V-block and includes raising and lowering of the head preparing to shift for another keyseat. The time in seconds represents the time



taken to sink the cutter to the proper depth, eliminating with this process the necessity of drilling clearance holes.

The diameter of spindle is 2 1/2 in. with a double taper on the end, the largest diameter of which is 4 3/4 in. The spindle is arranged to accommodate cutters with a short No. 4 Morse taper and has drift and retaining key slots. The work table is 11 in. wide over the working surface, and 16 1/2 in. wide over all. The length of the table over the working surface is 6 ft. 10 1/2 in. and 7 ft. 6 in. over all. The minimum distance from the bottom of the spindle to the top of the work table is 6 in. and the maximum distance is 18 in. The spindle speeds with 425 revolutions to the countershaft range from 1,194 to 430 r.p.m. with the back gears out and from 395 to 142 r.p.m. with the back gears in. There are nine changes of gear feed ranging from .115 in. to 10.09 in. per minute. The machine, when belt driven, is furnished with a cone having steps 9 in., 11 in., 13 in. and 15 in. in diameter and each 2 3/4 in. face. The machine occupies a floor space over all of 8 ft. 6 in. by 7 ft. As a standard, this machine is furnished with a table 4 ft. in length having an automatic feed in either direction of 36 in., but the particular machine illustrated is arranged to feed 6 ft.

The spindle revolves in bushed bearings, and has provision for taking up wear. It is driven by a runabout belt, either direct or through back gears, and is provided with micrometer measurement. Square lock bearings are provided on the saddle to the upright, and the adjustments are made by taper shoes. The work table is surrounded by an oil pan; the feed is obtained by means of a screw and revolving nut; the table has square lock bearings on the base; adjustment is made by taper shoes and the feed is available in either direction. There are nine changes of feed, hand adjustment and pump, piping and attachments for lubrication are furnished, the tank for which is in the base of the machine.

The V-blocks furnished are fitted with auxiliary parallels to accommodate the varying diameters and one of the blocks is mounted on a taper base to permit of raising it when operating on shafts having different diameters. In this photograph it will be noted the long helical spiral milling cutter supported at the bottom by an auxiliary support. This provision is made to handle elongated slots in shafting for hoisting machinery and particularly for locomotive piston rods, as it has been demonstrated to be a much more rapid and economical method of doing this work. The operation consists of drilling first a hole through the work the width of the keyseat, placing the shafts in the V-block and passing the cutter through to the bottom support when the feed is taken. On piston rods a special vise is furnished, permitting of the elevation of the work to obtain the one angular end.

These machines are in very successful operation and as average practice it may be mentioned that 13/16 in. diameter keyseats, 4 in. long, are being milled at the rate of 13/16 in. per minute. In addition to the work mentioned, a number of these machines are in use in key-seating locomotive axles and are said by the different firms to be the most rapid machines ever used on this work.

There is one particular advantage in sinking the cutter to the full depth, and then taking the feed, and that is that the bottom of the cutter can be made a little larger, insuring correct size and perfect fit at the top of the shaft on the key.

PIECE WORK IN THE BLACKSMITH SHOP

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ing piece work, he will naturally take to it. It has been my experience that when a man once gets a taste of working piece work you generally have trouble on your hands when you ask him to work day work. The piece work inspector should be a diplomat, a close observer and by all means fair and honest. A dishonest piece work inspector is a dangerous man to have around. This man generally fills a position of assistant foreman in a blacksmith shop and is among the men at all times, checking them up and inspecting their work and giving such orders as may be in his line.

"I believe it can be more satisfactorily worked in a large shop that does a great deal of manufacturing, as one man can be assigned to making some particular line of forgings. It can, however, be handled in a shop no matter how small: you may have a variety of different classes of work each day, and it is of course a little more difficult to work piece work than in the larger shop. Piece work and shop kinks go hand in hand. Take a piece work shop with a nice collection of shop kinks, and it is surprising to see the output that can be turned out per smith. There should be a liberal appropriation set aside for the tool room for making shop kinks for blacksmith shops.

To Make Granulated Babbitt Metal melt the babbitt in a ladle, remove the ladle from the fire, and allow the metal to cool. When it begins to "set," stir briskly with a stick until it has all cooled into a granular mass. If any particular size of grain is desired, the metal may be sifted using two screens, one of the desired size mesh to remove the large grains and one slightly smaller to allow the escape of the fine grains.

To Ascertain the Diameter and Pitch of the thread in a nut or a tapped hole in a casting or forging, particularly if it is a small one, some tap makers cast an expanding metal into the hole and then unscrew it. By reinforcing this with a small square piece of steel set in the hole before casting this can be unscrewed without difficulty. A good expanding metal is bismuth 2 parts, lead 1 part, and 1 part of tin.

STOCKBRIDGE TWO PIECE CRANK MOTION

All Stockbridge shapers are equipped with what is known as the Stockbridge patented two-piece crank moton, a special feature which gives to these machines an unique position and adds to their productiveness by reason of the even cutting speed obtained the entire length of the cut and the quick return. With the regular crank the speed must necessarily increase through the center of the stroke, and of course only that amount of cut can be taken that the tool will stand at its fastest speed. In this two-piece crank motion it will be readily appreciated from a study of the details that the speed is uniform.

The two-piece crank is a very compact arrangement, as the illustrations show, and its action, which may be clearly noted therein and in the diagram of the velocity curve, is most interesting.

Referring to the photograph showing the beginning, center and end of the cutting stroke, Fig. 1 shows the parts in their

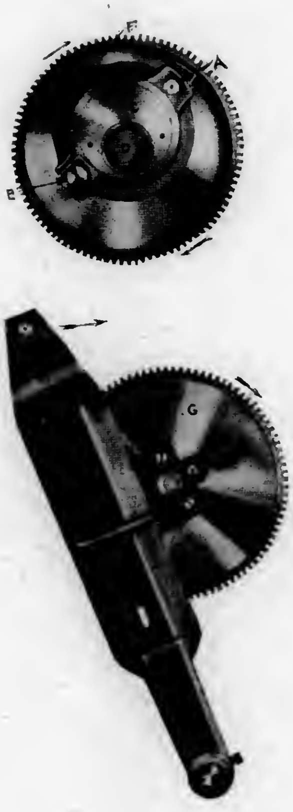


FIG. 1.

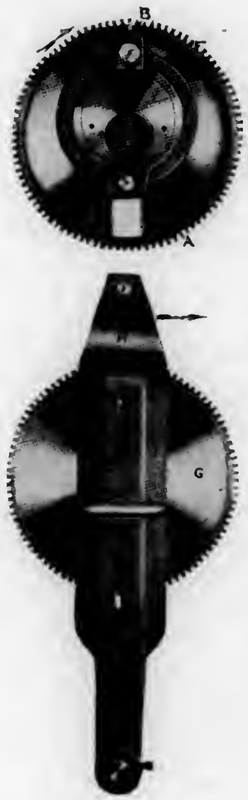


FIG. 2.

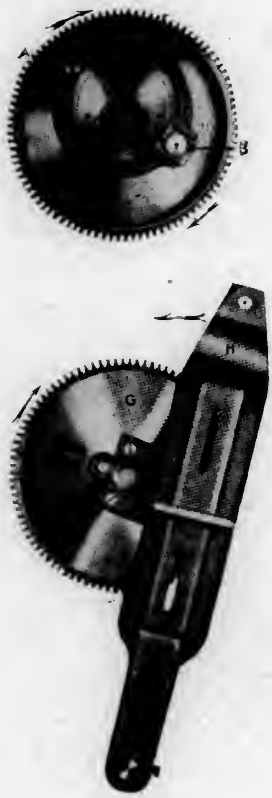


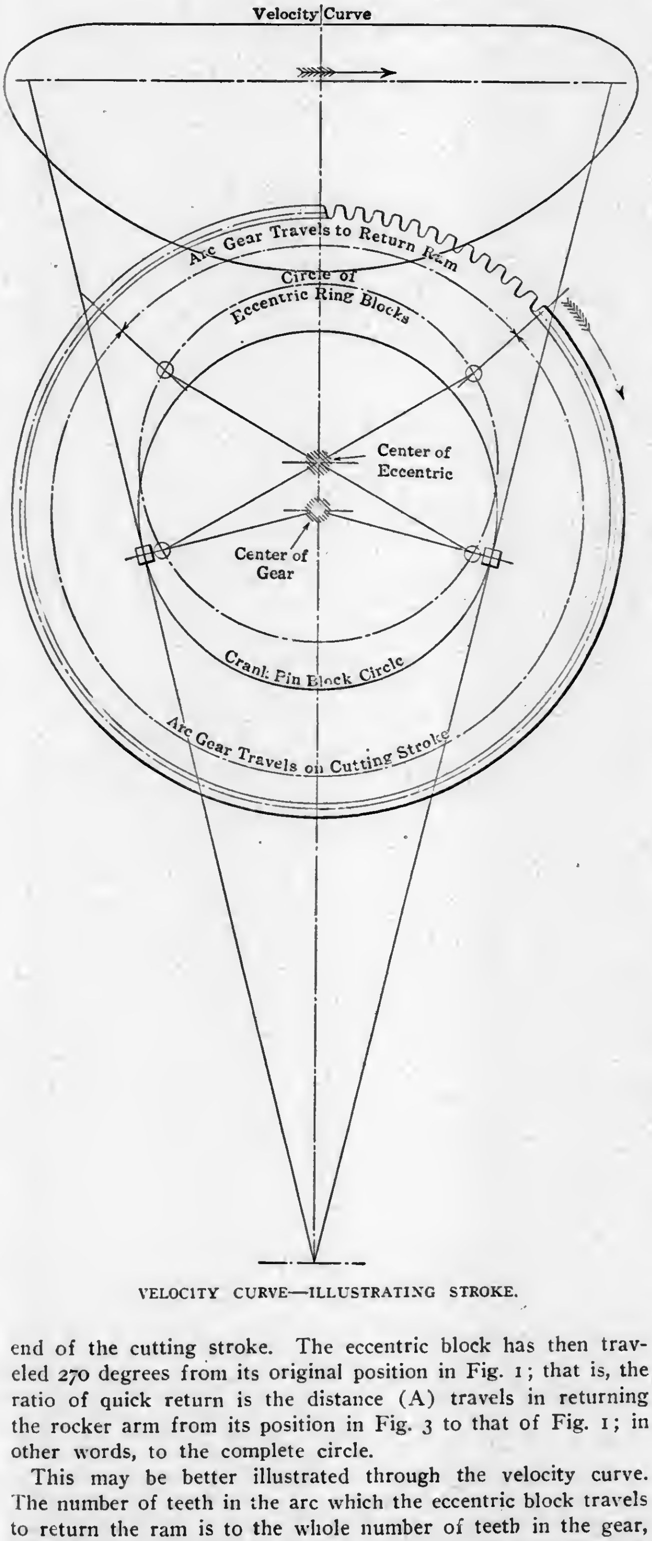
FIG. 3.

relative position, just as the ram is to start forward on its cutting stroke. In the following explanation it should be borne in mind that the gear is traveling at a constant speed all the time, and the position of the various parts should be carefully noted, particularly that the eccentric ring (E) travels around the eccentric (C). The latter does not move, but is keyed to the main bearing hub (D).

In Fig. 2 the rocker arm is shown in an upright position, which means that the ram has traveled one-half the length of the cutting stroke. By comparing positions shown in Figs. 1 and 2 the movement of the various parts can be followed, bearing in mind that the gear travels at a constant speed all the time. It will be noted that the eccentric block (A) has traveled from its original position as shown in No. 1, about 135 degrees of its entire circle. The eccentric ring crank block (B) which is diametrically opposite (A) and connected with it by the same piece, that is—the eccentric ring (E)—must have also traveled an equal arc of its circle, about 135 degrees, bringing it to a vertical position. The eccentric ring crank block (B) and crank pin block (I) are always in the same relative position; that is, and make from fifty to seventy-five cents more a day by work-

the position of the rocker arm can always be determined by the position of the eccentric block (B) or *vice versa.*

In Fig. 3, showing the end of the cutting stroke, it will be seen that the eccentric block (A) has moved approximately 135 degrees from its position in Fig. 2—the ram having reached the



VELOCITY CURVE—ILLUSTRATING STROKE.

end of the cutting stroke. The eccentric block has then traveled 270 degrees from its original position in Fig. 1; that is, the ratio of quick return is the distance (A) travels in returning the rocker arm from its position in Fig. 3 to that of Fig. 1; in other words, to the complete circle.

This may be better illustrated through the velocity curve. The number of teeth in the arc which the eccentric block travels to return the ram is to the whole number of teeth in the gear, which is 96, as 3.27 is to 1. This represents the actual quick return ratio for this particular size shaper. The power that is put into the shaper acts equally on every tooth of the gear, and that put into the Stockbridge, on the cutting stroke, is acting on more teeth, or for a greater length of time, as expressed by the quick return ratio, than is possible on a regular crank shaper. The circle which the eccentric ring blocks make in traveling around with the gear has a radius constantly varying from the center of the gear. It is this feature of varying distance that compensates for the varying speed of the regular crank shaper ram and gives to the Stockbridge an even cutting speed the entire length of the cut—the speed coming up gradually and reaching a maximum, remaining so to the end of the stroke where it drops off gradually just before reversing.

The following table shows the ratio of the Stockbridge 24-26 inch shaper. Note the high ratio of return on 1/4 length stroke and this ratio is maintained even down to one inch stroke.

On	full length	stroke	3	:	1.
3/4	"	"	13	:	5.
1/2	"	"	16	:	6.
1/4	"	"	31	:	14.

The following interesting test was made at the Worcester Polytechnic Institute by H. P. Fairfield:

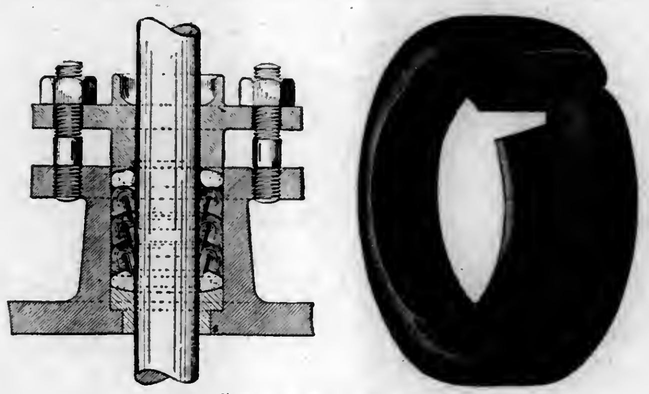
	Regular Crank Motion.	Stockbridge Crank Motion.
Depth of cut	1/4	1/4
Length of cut	12	12
Length of stroke	13	13
Feed per stroke	.0588	.0588
Cutting speed feed per minute	22	22
H. P. required	4.69	3.76

The patented two-piece crank motion showed in the above test a saving of 20 per cent. in power.

A NEW PISTON PACKING

Announcement has recently been made by the H. W. Johns Manville Co. of New York that it has secured control of the American rights for a successful English piston rod packing, which is called "Sea" rings.

This packing, shown in the accompanying illustration, is moulded of laminated material, either asbestos, flax or duck, depending upon the service, in the form of a wedge with the thin end turned inwards, leaving a hollow space in every ring between the lip and the heel into which steam can flow and force the thin edge against the rod. It is readily observed that when



"SEA" RING PISTON PACKING.

there is no pressure against the packing, as on every alternate stroke, the packing bears very lightly against the rod, but when pressure is placed on that side of the piston the packing holds with the pressure proportionate to that in the cylinder. The tightening up of the gland is not required to the extent necessary with soft packing, since all that is necessary is to hold the rings in place and the pressure of the gland is not required to prevent leakage.

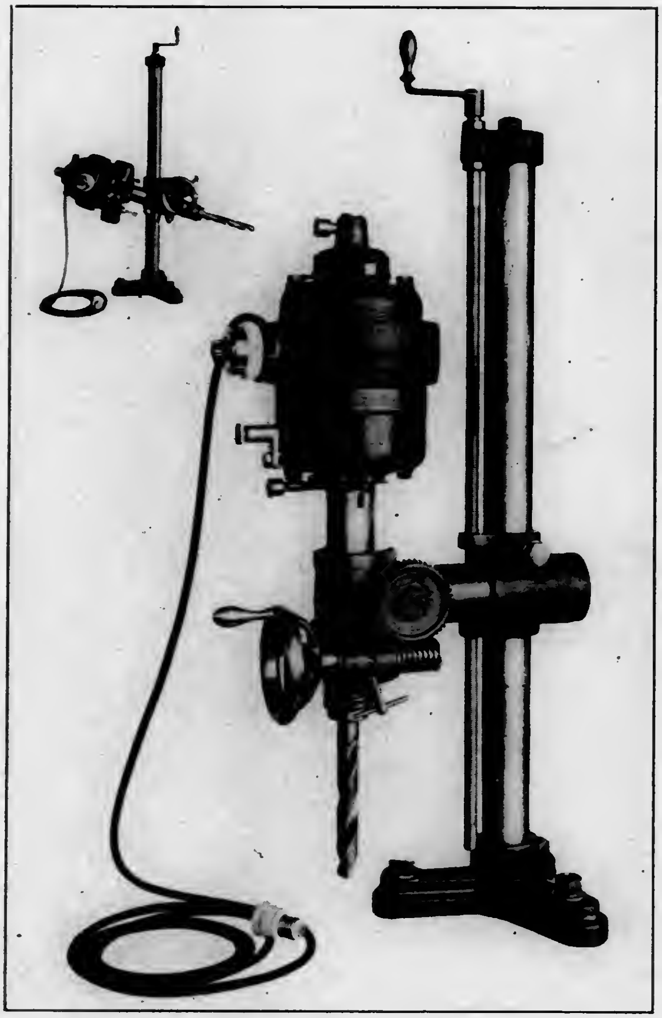
The advantages advanced for this form of packing are less wear on the rod; pressure against the rod proportionate to the tendency to leak, ease of application and long life. The rings will stand a temperature of 600 degs. F. and have been found thoroughly satisfactory for steam hammers, air compressors, engines, as well as for pumps of all kinds, to which they are particularly adapted.

IT IS PROPOSED TO HOLD a Smoke Abatement Exhibition in London next spring. The exhibition, which is being arranged by the Coal Smoke Abatement Society, will be held at the Royal Agricultural Hall, and will last a fortnight.

A PORTABLE ELECTRIC RADIAL DRILL

The very efficient portable electric drill herewith illustrated has been recently placed on the market by the Lamb Electric Company, of Grand Rapids, Mich. The machine will bore holes up to one inch diameter in any position. Its extreme height is 40 in. and the greatest distance from the spindle to the base 28 in. The total weight of the drill is between 130 lbs. and 150 lbs., according to the kind of motor used.

The illustration well depicts the universitality of the machine It may be clamped to the work if desired, and when once



clamped is ready for use, the adjustment necessary being the raising or lowering of the drill by the handle at the top, rotating about the steel column or rotating about the drill arm. It will save considerable time on large heavy work that cannot be conveniently handled by large radial drills.

The largest drilling radius is 8¼ in., but any of these limitations may be made greater to suit conditions. The column is made of steel tubing, 2½ in. diameter. The spindle has a socket for a No. 3 Morse taper, and has a travel of 5 in. by means of a rack and pinion which may be operated by the hand wheel or by power through the worm and wheel as shown. The machine may be equipped with a quick return when so ordered. If desired, two speeds will be furnished and the change from one to the other may be made instantly by the shifting of a knob.

It is Believed that within five years the subway lines of Greater New York will be carrying 800,000,000 passengers per year.

WENTWORTH INSTITUTE

There has just been opened in Boston a new industrial school made possible by the will of Arioch Wentworth, who left over $3,500,000 to endow a school to furnish education in the mechanic arts. This school is intended primarily for young men who are already employed and also for those who wish to train themselves for either manufacturing or building trades with some practical skill at the start.

Both day and evening courses will be offered, the day courses being of two types, short one year courses and more thorough two year courses. The first are but six dollars per term for day students and six dollars for the season of two terms for evening students. Part time courses are also offered, which require students to attend classes at the institute every other week.

The equipment already provided is of the highest class and very carefully selected for its purpose. It is intended that one-half of the time of the student shall be devoted to practical work in ideal modern shop conditions, the other half being instruction or laboratory work.

Arthur L. Williston, for many years the head of the School of Science and Technology of Pratt Institute, Brooklyn, N. Y., has been selected as principal of this school.

PERSONALS

A. A. McGregor has been appointed assistant master mechanic of the Louisville & Nashville Ry. at Evansville, Ind.

V. M. Sisk has been made master smith of the Baltimore and Ohio R. R. at Pittsburg, Pa., vice George Judy, resigned.

D. W. Cross has been appointed acting master mechanic of the Toledo, St. Louis & Western Ry., with office at Franklin, Ind.

William C. Weldon has been appointed purchasing agent of the Colorado Southern R. R., with headquarters at Denver, Colo.

I. L. Ulrey has been appointed foreman of the air brake department of the Chicago & Eastern Illinois R. R., with office at Oaklawn, Ill.

A. S. Abbott, master mechanic of the Frisco system at Sapulpa, Okla., has been appointed mechanical superintendent of the First district.

Edward Huges is now purchasing agent of the Lehigh & New England Railroad, headquarters at Lansford, Pa., J. B. Whitehead having resigned.

F. E. Bates has been appointed assistant superintendent of locomotive fuel service of the St. Louis & San Francisco Ry., with office at Francis, Okla.

M. Dailey has been appointed master mechanic of the Bellingham Bay & British Columbia Ry., with office at Bellingham, Wash., succeeding W. J. McLean, resigned.

P. H. Reeves, motive power inspector of the Baltimore and Ohio Southwestern Ry., has beeen appointed master mechanic at Chillicothe, O., vice George F. Hess, resigned.

P. C. Moeller has been appointed night roundhouse foreman of the Rock Island Line at Silvis, Ill., vice J. Fitzgerald, transferred to the Forty-seventh street shop, Chicago.

F. M. Gilbert, mechanical engineer, New York Central and Hudson River Railroad, has resigned to become assistant general superintendent of the New York Air Brake Co. at Watertown, N. Y.

William E. Rockfellow, general car foreman of the New York Central, has been appointed superintendent of the car department of the St. Lawrence and Ontario divisions; office at Oswego, N. Y.

H. Weitzel has been made master mechanic of the shops of the Southern Pacific of Mexico at Empalme, Sonora, Mex. He was formerly superintendent of those shops, which position is now abolished.

T. T. Cloward, foreman of locomotive repairs of the Philadelphia, Baltimore & Washington R. R., at Bay View, Md., has been appointed general foreman of the Wilmington (Del.) machine shops.

Walter Coon has been made master boiler maker of the New York Central at W. Albany, N. Y., vice G. W. Bennett, resigned to become district federal boiler inspector of District No. 3, office at Albany.

H. Marsh, general car foreman of the Baltimore and Ohio Southwestern Ry. at Washington, Ind., has been appointed general car foreman of the Iowa Central at Marshalltown, Ia., vice W. E. Looney, resigned.

W. O. Thompson, master car builder of the New York Central at East Buffalo, N. Y., has had his authority extended over territory west of Syracuse, including the St. Lawrence, Ontario and Pennsylvania divisions.

H. A. Witzig has been appointed master mechanic of the Missouri Southern Ry., in charge of shop and rolling stock, with office at Leefer, Mo. Mr. Witzig succeeds Thomas Goulding, resigned to accept a position with the Chicago, St. Paul, Minneapolis & Omaha Ry.

W. H. Donley has been made master mechanic of the Illinois Central R. R. at E. St. Louis, Ill., vice F. G. Colwell, resigned to become master mechanic of the Delaware, Lackawanna & Western R. R. at E. Buffalo, N. Y.

John Forster has been made mechanical superintendent of the St. Louis & San Francisco, with headquarters at Springfield, Mo. Mr. Forster for eleven years has been master mechanic of the Kansas City division of that road.

G. E. Carson, master car builder of the New York Central at West Albany, has had his authority extended and is now in charge of the territory east of Syracuse, including the Hudson, Harlem and Putnam divisions.

C. D. Young, assistant to the General Superintendent of Motor Power of the Pennsylvania Lines west of Pittsburg, has been appointed engineer of tests of the Pennsylvania Railroad at Altoona, Pa.

George Seanor, division foreman of the St. Louis & San Francisco at Joplin, Mo., has been appointed general foreman of shops, with office at Sapulpa, Okla., succeeding J. F. Long, promoted. J. Morgan has been appointed assistant to the general foreman of shops at Sapulpa.

David Hawsworth, for many years superintendent of motive power for the Burlington Lines west of the river, died at Plattsmouth, Nebraska, Friday, August 25, in his 80th year. Mr. Hawksworth was born in England and first began railroad work in the machine shops of the Manchester, Southern and Liverpool Railroad. He came to America in 1849 and after thirteen years alternate service in railroad and steamboat service he enlisted in the United States navy as second assistant engineeer. On being mustered out in 1864 he returned to Burlington, where he remained until 1875 working for the Burlington road. In that year he was appointed master mechanic and was made superintendent of motive power in 1888. He was retired in 1901 at the age of 70 years. He was often called upon for advice after retirement by the managers of the road and his opinions were given much weight. Mr. Hawksworth leaves a widow and five children.

CATALOGS

Grinding Wheels.—The Norton Company, of Worcester, Mass., has just issued a booklet entitled "Safety as Applied to Grinding Wheels," which constitutes a valuable and timely publication in view of the national interest in accident prevention and relief. It illustrates and describes modern safety devices that can be practically applied in the use of grinding wheels and machines.

Electrical Machinery.—In bulletin 3107, 3142 and 3143 the Emerson Electric Mfg. Co., of St. Louis, Mo., illustrates and describes respectively its electric buffing lathes, single phase induction motors, and single phase induction motors back-geared with countershaft. In addition to the complete descriptive matter, the bulletins contain much valuable information for the users of these appliances.

Standard Tool Co.—This company of Cleveland, O., announces the opening of a Western branch at 552 West Washington Boulevard, Chicago, Ill. In this store a complete stock of all styles of twist drills, reamers, milling cutters, taps, drill chucks, taper pins, etc., manufactured by the company will be carried for immediate delivery of orders. The Standard Tool Co. feels sure that the convenience of the new arrangement will be appreciated by the trade in Chicago and the West.

Water Softeners.—The L. M. Booth Company of New York, N. Y., has prepared a booklet describing some standard types of softeners and illustrations of representative installations in active service are also included. The catalog has been confined to the consideration of softeners adapted to the usual requirements, it being thought preferable to reserve for correspondence the discussion of special equipment, which, of course, is of less general interest.

Steel Derricks and Drilling Rigs.—A very complete treatise on the above appliances has been compiled and is now issued in booklet form by the Carnegie Ssteel Company, of Pittsburg, Pa. Three types of derricks are described and illustrated—the Woodworth Standard, the Woodworth Oklama and the Yorke Standard—all of which have their respective advantages. The book contains working drawings and half-tone illustrations and is replete with valuable data on the general subject.

Tank Governors.—The Fulton tank governor, which has been thoroughly tested in railroad service, is described and illustrated in a catalog issued by D. W. Patterson, Harrison Bldg., Philadelphia, Pa. This tank governor is designed to maintain the water level at any desired height with but little variation in tanks, stand pipes, reservoirs, water towers, etc., as to maintain a pressure in water mains at any desired head. It dispenses with the use of float valves or electrical devices for controlling the height of water, but does not prevent their simultaneous use.

Railway Telephones.—The United States Electric Co. of New York, N. Y., sole manufacturers of the Gill selector, has published bulletin No. 502, containing suggested rules for telephone train despatching. These suggested rules have been drawn up in response to requests from the company's patrons for recommendations for this service. They are by no means mandatory, but may be considered as indicative of approved practice, as they embody in the main the requirements appearing in the rules of the principal railway systems using telephone train dispatching.

Ball Bearings.—The Hess-Bright Mfg. Co., of Philadelphia, Pa., has issued leaflets Nos. 68, 69, 70 and 71, in series 336, describing and illustrating respectively the application of floating bushes to grinding machine spindle, method of assembling an adapter with mountings, D. W. F. adapter, and the method of assembling it with bearings on a straight shaft, and ball bearings in horizontal moulding machines. These sheets are in the usual folio size, and prepared for binding. They constitute a valuable addition to past literature on this subject which has been issued by the Hess Bright Company.

Electric Locomotives.—The C. W. Hunt Company of New York, N. Y., was among the pioneers in the development of the electric locomotive for handling trains of industrial railway cars, and when introduced it rapidly

gained favor in those fields where steam and manual power were formerly employed. Its success has been so remarkable that it is now regarded by many purchasers of the industrial railway as a necessary element of the installation. In a recently issued catalog the Hunt Company gives a description of the locomotive, together with illustrations of plants showing it in operation under varying conditions.

Gas-Electric Motor Cars.—The need for self-propelled cars as adjuncts to the regular equipment of steam roads has been apparent for many years, and to-day the General Electric Company, of Schenectady, N. Y., is furnishing such cars capable of fulfilling steam road requirements with economy and reliability. In a recently issued very attractive catalog the company describes and illustrates its gas-electric motor car in detail which leaves nothing to be desired from an informative standpoint. The make-up of the book is artistic to a high degree, and it contains much valuable general information on the subject on which it treats.

Planers.—The new catalog issued by the Niles-Bement-Pond Company, of New York, N. Y., illustrates a variety of planers made to conform with the requirements of modern machine tool practice. The description which it includes of reversing motor drive is of special interest. This arrangement is noteworthy on account of its simplicity, and because of the increase in tool efficiency obtained by its use. By decreasing the number of moving parts the maintenance charges are materially reduced, and the increase in the number of variations of cutting and return speeds available makes any given size of machine suitable for a very wide class of work. This type of drive is now applied to any size or type of reversing planer.

Pulsometer Steam Pumps.—The Pulsometer Steam Pump Co., of New York, N. Y., has just issued a new catalog which in reality constitutes a complete treatise on this pioneer of the vacuum type of steam pump. The descriptive matter is thorough and is enhanced by very clear sectional drawings and half tones which render easily understood the construction and operation of the device. The catalog contains a number of illustrations from actual practice showing every application of the pulsometer to construction, quarry and bridge work from which it may be gathered that it constitutes an ideal machine for contractor's use. The latter portion of the catalog contains tables and information of value to steam pump users.

Electric Motors.—Bulletin No. 4869, just issued by the General Electric Company, is an attractive publication devoted to motor drive for the printing and allied trades. The advantages to be derived from motor drive in this industry are the improved plant location made possible by the use of central station power, reliability, speed variation and control, economy of space, increased production, economy of power, and, what is exceedingly important in the printing trade, cleanliness. The publication illustrates motors and the necessary controllers, for both direct and alternating current circuits, and applicable to job and cylinder presses of all sizes and kinds, and to stitching, perforating, cutting, numbering, folding and punching machines.

Another Bettendorf Bear Book.—The children of the railway fraternity will be overjoyed to know that the Bettendorf Axle Company has issued another story of the Bettendorf bears by Bruce V. Crandall, entitled "Goldenhair and the Bettendorf Bears." It tells in rhyme of the wonderful experiences of a general manager's little daughter who was conducted over the Bettendorf plant in Animal Town by her friends the bears. Here she was shown many wonderful things and became fascinated with the inhabitants of Animal Town and the work they did in their factory. The illustrations are particularly well executed and well suited to the little folk to whom the book is dedicated.

Electrical Machinery.—The General Electric Co., of Schenectady, N. Y., has issued Bulletins Nos. 4819, 4825, 4826, 4827 and 4831, descriptive respectively of alternating current switchboard panels; General Electric switchboard instruments; water meters, air flow meters, and oil break switches for manhole service. As usual in the instance of the General Electric Co.'s bulletins, the various subjects are fully discussed and appropriately illustrated. In particular Bulletin No. 4819 on alternating current switchboard panels is of exceptional value, as it clearly defines and explains many terms and points, a knowledge of which is not widely diffused outside of the electrical engineer's profession.

Walschaert Valve Gear.—Record No. 70, issued by the Baldwin Locomotive Works, Philadelphia, Pa., is devoted to a thorough description of this gear, supplemented by a number of finely executed half tones and line drawings. The feature of particular value in connection with the record is a detailed method of setting valves with the Walschaert gear, both for outside and inside admission, and which is one of the most comprheensive and lucid analysis of the operation that has yet appeared in print. Hypothetical cases are introduced which graphically portray irregularities and the method of their correction. Since the year 1905 the Walschaert valve gear has come to be more generally employed than any other form of motion, and this fact endows the record with a particular value at this time.

Ball Bearing Hangers.—Under this title the Hess-Bright Mfg. Co. of Philadelphia, Pa., has issued a very attractive and instructive catalog dealing with the construction and application of these devices. In the purchase of the equipment of a new factory, or in the remodeling of an existing plant, often very little consideration is given to the selection of the hangers to hold and support the line and counter-shafting. To many shop owners a hanger is simply a "hanger," no thought being given to the saving that can be effected through the elimination of friction and the consequent increased efficiency of the power plant. The pages of this catalog contain information that will prove of interest to every power user, and the valuable data which it embodies renders it an important addition to the existing literature on the subject.

Reflex Water Gages.—The Jerguson Gage & Valve Company, of Boston, Mass., has recently issued a booklet descriptive of reflex water gages (Klinger type) which are adapted for use on marine, locomotive and stationary boilers, separators, tanks, etc. The reflex gage involves a simple and fundamental principle of the law of optics, namely, the total reflection of light when passing from a body of greater refractive into one of less refractive power. This gage insures quick and accurate reading of the water level, as the water always appears black, and white indicates immediately the absence of water. The catalog is handsomely illustrated in color and includes also a description of the various types of water glass fittings manufactured by the Jerguson Company.

Rings, Shells and Ring Dies.—The Standard Steel Works Co., Philadelphia, Pa., have just issued a new catalog on rings, shells and ring dies. This very interesting publication contains illustrations of the various types of this class of material, such as are used in the Chilean, Huntingdon, Griffin or Bradley, Kent, and Bryan Mills, as well as cuts of rolled steel rings which are used for various other purposes. The catalog also contains cuts showing gear rims and blanks for built-up gears for heavy electric service, built-up wheels for Bascule bridges, and wheels for mining service. On the last few pages it contains tables of dimensions of peened, screw, welding and plain pipe flanges as well as fac-simile of dimension blanks used is the ordering of wheels.

The Jacob Schupert Sectional Firebox.—A most attractive and interesting treatise, confined to a description of the features of the Jacob Schupert firebox, is being issued by the Jacob Schupert U. S. Firebox Company, 30 Church St., New York. It is a book of 100 pages, printed on heavy calendered paper and illustrated with most excellent reproductions from photographs and deals in detail with the construction and advantages of this type of firebox in correcting the known disadvantages of the present arrangement. The unfavorable features of the present locomotive firebox are clearly recognized by all, and it is believed by the manufacturers that this design, with which our readers are fully acquainted, corrects practically all the troubles now experienced. This book, bound in cloth, is very complete in all its features and will be found very valuable by all interested in locomotive boilers.

NOTES

Standard Tool Co.—This company, of Cleveland, O., has appointed L. Hussey to the position of advertising manager.

Baldwin Locomotive Works.—It is announced that the Portland, Oregon, office of the above company has been moved from 809 Couch Building to 722 Spalding Building.

Ashton Valve Co.—J. W. Motherell, assistant to the vice-president of the Ashton Valve Co., Boston, Mass., has been appointed vice-president and manager of the railway department.

S. Severance Mfg. Co.—S. Severance, who has been President and Manager of the S. Severance Manufacturing Company since its formation, severed his connection with that company on September 1st.

Prentiss Tool & Supply Co.—Announcement is made by this company, of New York, N. Y., of the removal of its office and salesroom from 115 Liberty Street to the Singer Building, 149 Broadway, New York.

Dearborn Drug and Chemical Works.—Thomas H. Platt, who is well known to the engineers of New York, is now associated with the above company and will make his headquarters at the Eastern office, 299 Broadway, New York. Mr. Platt's territory will comprise Greater New York.

Homestead Valve Mfg. Co.—Announcement is made by this company, of Pittsburg, Pa., of the appointment as agents in Scranton and vicinity of Charles P. Scott & Company of 119 Franklin avenue, that city, who will be ready to supply the trade at all times.

Best Manufacturing Co.—Benjamin T. Delafield, who formerly represented the Lunkenheimer Company for a number of years in the St. Louis and Kansas City territory, has become connected with the Best Manufacturing Company of Pittsburgh, Pa., to handle their line of valves, fittings, flanges, pipe bends, fabricated pipe and other power plant material in the same territory. He will make his headquarters in Kansas City.

American Locomotive Co.—The tenth annual report of this company for the fiscal year ending June 30th shows that the gross earnings for the year, $40,649,385, were $8,445,993 greater than the preceding year and over twice as large as the year 1908-9. The surplus, after a charge for depreciation on all classes of property of $1,056,417 and the payment of the preferred dividend, was $1,815,561, as compared with $334,758 in the preceding year.

The Speed and Acceleration Problem

By G. E.

HAVING THE CHARACTERISTIC CURVES OF AN EXISTING OR PROPOSED LOCOMOTIVE, A METHOD OF ACCURATELY DETERMINING THE SPEED AND TIME WHICH IT WILL GIVE WITH ANY ASSUMED TRAIN FOR ANY PARTICULAR SECTION OF AN EXISTING OR PROPOSED ROAD, IS DEMONSTRATED IN THIS ARTICLE.

The necessity occasionally arises for estimating the time in which a proposed motive power not yet built, or to be altered, can pass over an existing road or a proposed line. This would be very simple if the tractive effort of the locomotive or motor car and the resistance of the train were constant at all speeds, and the methods which appear to have heretofore been used for this kind of work are based on the assumption of a constant difference between the tractive force and the resistance through the whole range, or through part of the range, of speed variation.

Actually this difference, or unbalanced tractive effort, decreases as the speed increases, and becomes zero if the train reaches the "balancing speed," or the velocity at which the tractive effort just equals the resistance. If, now, the length of track under a given condition of grade is sufficient to enable the train practically to reach the balancing speed, a superficial view would suggest that correct results could be obtained by taking half the initial unbalanced tractive effort as the average accelerating force, and substituting it in the well-known formulas:

$$f = m\,a = \frac{w\,a}{g} \qquad \text{(1)}$$

$$a = \frac{f}{m} = \frac{f\,g}{w} \qquad \text{(2)}$$

$$v = a\,t = \frac{f\,g\,t}{w} \qquad \text{(3)}$$

$$s = \frac{a\,t^2}{2} = \frac{f\,g\,t^2}{2\,w} \qquad \text{(4)}$$

in which f = the accelerating force.
m = the mass of the train.
a = the acceleration in feet per second per second.
w = the weight of the train in pounds.
g = the acceleration due to gravity = 32.16 ft. per second per second.
v = the velocity in feet per second.
t = the time in seconds.
s = the distance in feet.

But, since the unbalanced tractive effort at the start is much larger than assumed, the speed increases very rapidly at first and very slowly when the balancing speed is approached, with the result that the average speed is much greater than it would be under the conditions substituted for the real ones. Consequently, the distance traveled will not be even approximately correct. A closer approximation can be made by successive calculations for short intervals of time. For example, if intervals of five seconds are chosen, the velocity and distance during the first interval from the start are calculated from equations (3) and (4) respectively. Then the unbalanced tractive effort at the velocity just found, is used for f in equation (3) to find a new velocity to be added to that acquired in the first interval. The distance traveled in the second interval is

$$s' = v'\,t + \frac{f\,g\,t^2}{2\,w}$$

in which v' is the speed at the beginning of the interval, in feet per second. The process is then carried out for a third interval, and so on. There are various modifications of these methods, some so erroneous as to be useless, and others in which a degree of approximation is reached through a method too laborious for an extensive study, but the preceding are believed to be typical.

A simple and novel method has recently been devised for this kind of work, which the writer hopes will be of interest. While

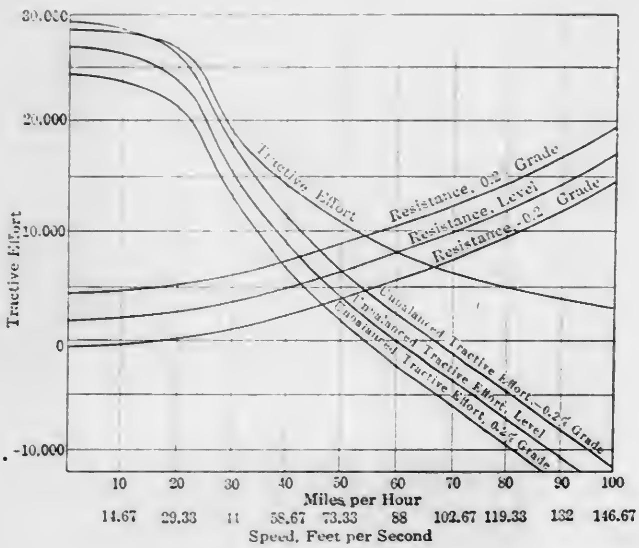


FIG. 1.

some will brand it as "theoretical," and would prefer to build the motive power and the road first and to tell afterward what time can be made, the business man wants to know what the results will be before expenditure is made. When, therefore, orders are received that such an estimate is to be submitted, there is a very practical phase to any method that enables it to be made with a good degree of accuracy and at a reasonable cost. While the data should be determined with the utmost care, the actual work is little else than planimetry and plotting.

First the tractive effort and the train resistance are plotted as shown in Fig. 1. Much has been printed in the technical papers, in books, and in the proceedings of the engineering societies on tractive effort and train resistance, and the engineer should satisfy himself through such sources and his own experience as to the correctness of these curves, for the reliability of the whole work depends upon them. It may be necessary to plot

resistances for other grades as well as those shown. The curve of accelerating force, or unbalanced tractive effort, is, of course, plotted by taking differences between the total tractive effort and the resistance; for example, at 50 miles per hour the tractive effort is 10,600 lbs., the resistance on the 0.2 per cent. grade is 8,900 lbs., and the unbalanced tractive effort is 1,700 lbs. For

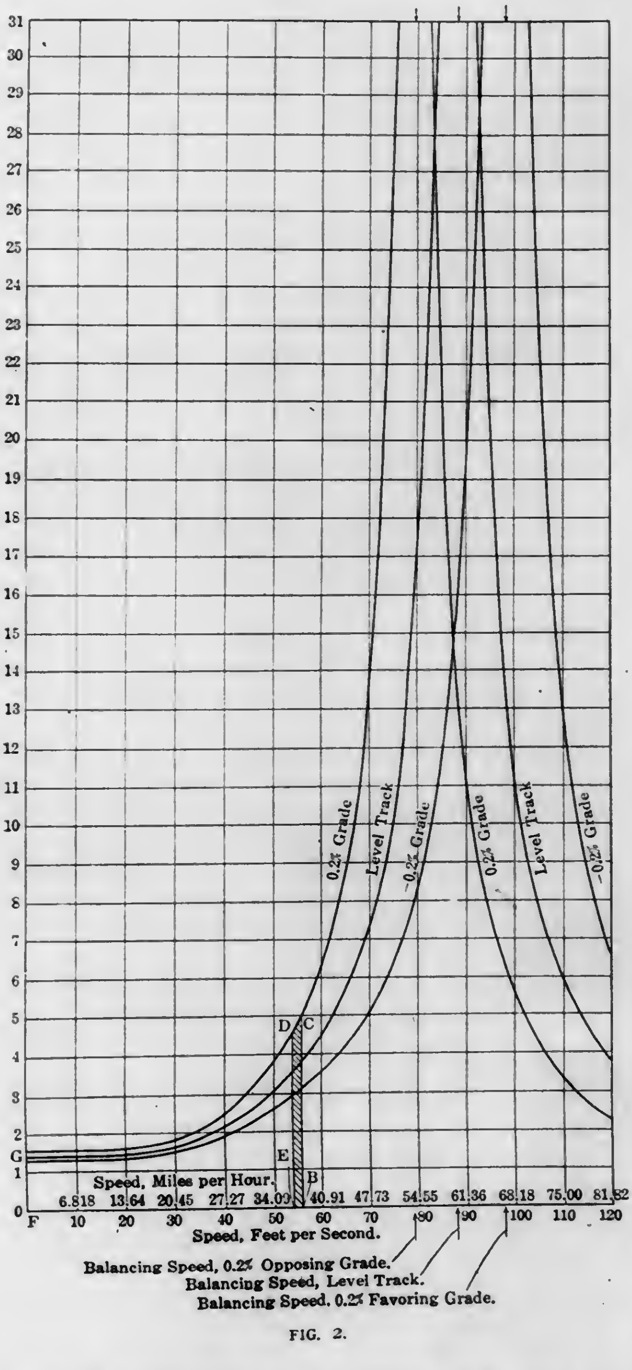


FIG. 2.

any grade the tractive effort and resistance curves cross at the balancing speed, and the curve of unbalanced tractive effort crosses the zero line at the same speed.

In Fig. 2 are plotted values of $\frac{1}{a}$ or $\frac{w}{gf}$ (see equation 1), the value of f being taken from Fig. 1 for each speed plotted. Since the accelerating force is not absorbed in the linear acceleration alone, but must alter the angular velocity of the wheels and axles, an allowance for this extra effort must be made. This can be done by adding to the weight of the train the values of $\frac{g\,I}{r^2}$ for all the rotating parts, which may be expressed as $\Sigma \frac{g\,I}{r^2}$, I being the moment of inertia and r the radius of the tread of the wheel. I is, of course, equal to $\Sigma \frac{w\,q^2}{g}$, where w is the weight of an elementary particle of the wheel and q its distance from the center. The allowance for the rotating parts may be expected to lie between 2 per cent. and 8 per cent. of the total weight.

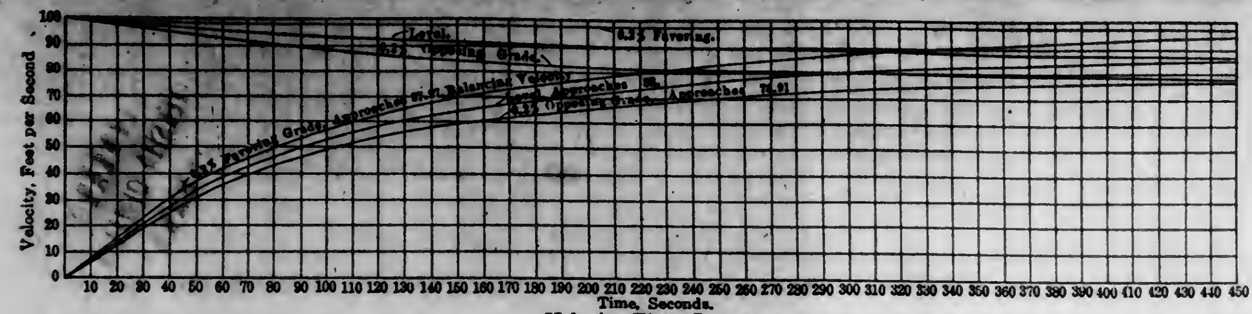
Under favorable circumstances a train may reach a given grade at a speed higher than the balancing speed. It will then be retarded, and the acceleration as well as its reciprocal will have negative values. The curves at the right-hand side of Fig. 2 should strictly, therefore, be inverted and placed below the zero line, so that the complete curve for any grade passes from the positive to the negative values through the infinite value at the balancing speed. The curves are all plotted above the zero line, however, on account of the convenience of the small diagram.

Now let dv represent the small increase in velocity from E to B (Fig. 2), and let dA represent the area of the small strip $B\ C\ D\ E$.

$$dA = \frac{w}{f\,g}\,dv \text{ (nearly).}$$

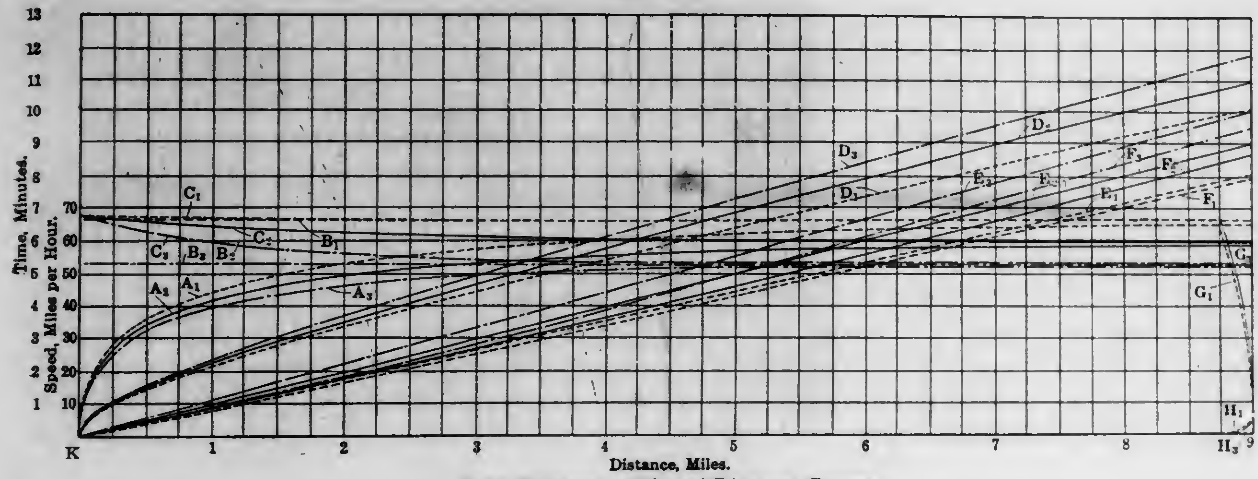
But (equation 2) $a = \frac{f\,g}{w}$ and a, being the rate of change of speed with reference to the time, is equal to $\frac{dv}{dt}$, in which dt is the short interval of time in which the speed increases from E to B. Then $dA = \frac{1}{a}\,dv = dt$. That is, the area $B\ C\ D\ E$ is equal to the time required for the velocity to increase from E to B, and the whole area $B\ C\ G\ F$ must equal the time required to reach the speed indicated at B from the start. This principle is applied in plotting the velocity-time curves of Fig. 3. For example, the time to plot horizontally at the height of the speed of 30 feet per second is equal to the area under the acceleration-reciprocal curve of Fig. 2 between the zero and 30 ordinates and that for the speed of 50 feet per second is similarly obtained from the area between the zero and 50 ordinates. The planimeter should, of course, be adjusted to the scales and units of measurement adopted, or the results should be multiplied by the proper factor. For the retarded velocity, in this case plotted from that of 100 feet per second, areas are measured to the left from the 100 feet per second ordinate. The problem of the momentum grade is an extreme case of retarded velocity. These speed curves should approach indefinitely the balancing speed indicated in Fig. 1.

Since the distance traveled in a short interval, dt, is equal to $v\,dt$, it follows that the total distance traveled in a given time is equal to the area under the velocity-time curve of Fig. 3. By measuring these areas, therefore, distances are found at which both the time and the speed can be plotted as in Fig. 4. The speed-distance curves should approach the balancing speed indefinitely, and the time-distance curves should approach indefinitely the condition of being straight lines parallel to the inclined straight lines representing the time-distance relation if the train had been traveling all the time at its balancing speed. The vertical distance between these lines represents the time lost in accelerating. For example, if the train passes a given point on a 0.2 per cent. grade at its balancing speed, about 54 miles per hour, it will reach a point seven miles beyond in 7.8 minutes. But if it is started from a stand-still it would require



Velocity-Time Curves.

FIG. 3.



Time-Distance and Speed-Distance Curves.

Subscript "1" and dotted lines indicate 0.2 per cent. favoring grades.
Subscript "2" and full lines indicate level track.
Subscript "3" and broken lines indicate 0.2 per cent. opposing grade.
Curves *A* show speeds from start.
Lines *B* show balancing speeds.
Curves *C* show speeds from 100 ft. per sec., or 68 miles per hour.
Curves *D* show distances from start.
Lines *E* show distances at balancing speed.
Curves *F* show distances from a speed of 100 ft. per second or 68 miles per hour.
Curves *G* show speeds with brake applied.
Curves *H* show distances with brake applied.

FIG. 4.

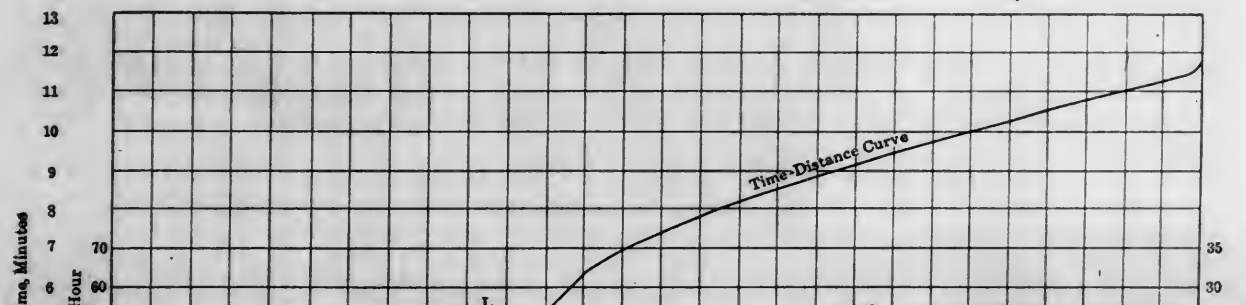


FIG. 5.

about 9.6 minutes to travel those seven miles, and 1.8 minute would have been lost.

The speed and distance curves for the brake can be found in the same way, but the deceleration for the brake is so much nearer constant, and the time when the brake is applied is so short, that the formulas (3) and (4) can be used without serious error.

The final result is to be exhibited in such a diagram as Fig. 5, in which the same scales for time, speed and distance are adopted as in Fig. 4. The grades are compensated, and the profile laid off on tracing cloth. It is assumed that the speed during the latter half of the third mile is to be limited to 15 miles per hour on account of operating conditions. The track starts with a 0.16 per cent. grade. The tracing cloth being placed on Fig. 4 so that *H* and *K* coincide, the time curve *H I* and the speed curve *H J* are drawn, interpolating between the curves

for level track and for 0.2 per cent. in Fig. 4. The cloth is then moved horizontally until *J* falls on the speed curve for level track, and *J L* is traced. Then the cloth is moved vertically until *I* falls on the distance curve for level track, and *I M* is drawn. *N O* is drawn at 15 miles per hour, and *N* is placed so that it falls on the brake curve. *L N* is then drawn to meet the previously drawn speed curve, and the cloth moved vertically until *M* falls on the distance curve for the brake, when *M P* is drawn. The remainder is traced in a similar way.

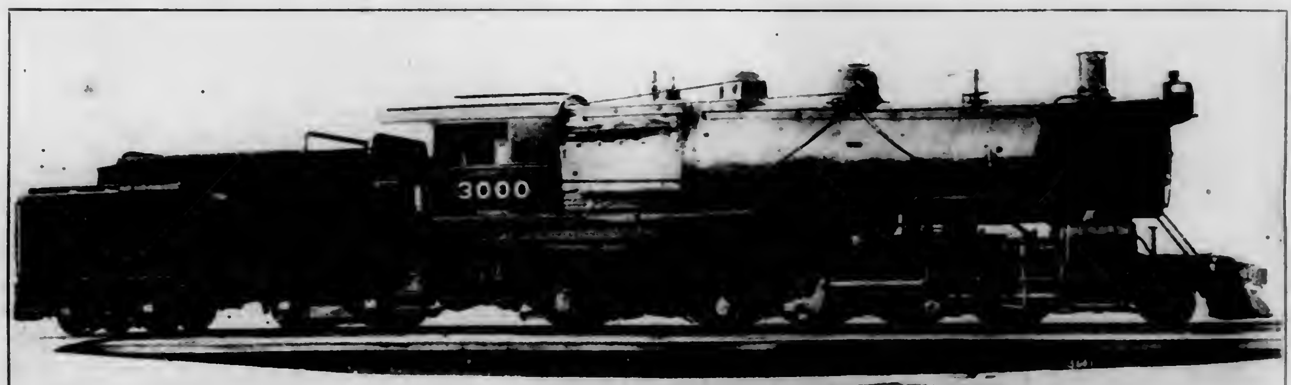
Although the explanation of the method is somewhat tedious, the actual work is much simpler than accurate calculations. The use of curves makes it unnecessary to plot so many points as would have to be calculated, and the relations of the curves are so apparent that an error would be quickly discovered. Moreover, the diagram of Fig. 4 having once been made, can be applied to any number of miles of the final Fig. 5 diagram.

Superheater Locomotives 2-8-2 Type

GREAT NORTHERN RAILWAY.

TWENTY LOCOMOTIVES RECENTLY DELIVERED BY THE BALDWIN LOCOMOTIVE WORKS, WHICH HAVE BEEN PUT IN SERVICE ON THE GREAT NORTHERN RAILWAY, ARE AMONG THE MOST POWERFUL OF THE SIMPLE LOCOMOTIVES ON OUR RECORD, BEING PRACTICALLY EQUIVALENT TO THE MALLETS WHICH THAT COMPANY HAS IN ROAD SERVICE.

As our readers are well aware, the past year has shown a great revival of interest and a very general development of the 2-8-2 or Mikado type locomotives for freight service. This design has been continually enlarged and improved, greatly surpassing anything which was considered possible when it was practically abandoned four or five years ago until it now occupies a position which, until a comparatively recent period, it was believed could be covered only by the Mallet type. The reason for this renewed lease of life will be found principally in the success of the high degree superheater which has so greatly increased boiler capacity as to permit a boiler of sufficient capacity per unit of weight to be mounted on four coupled drivers without exceeding a safe axle load, and enable the locomotive to deliver a very high ratio of its maximum tractive effort at moderately high speeds. In the September issue, on page 346, will be found a discussion of the comparative merits of the consolidation and the Mikado type locomotive, wherein it is pointed out that while the maximum theoretical tractive effort of the Mikado could be attained by the consolidated type, it is the sustained high tractive effort at high speed, which means boiler capacity, that is assured by the former.

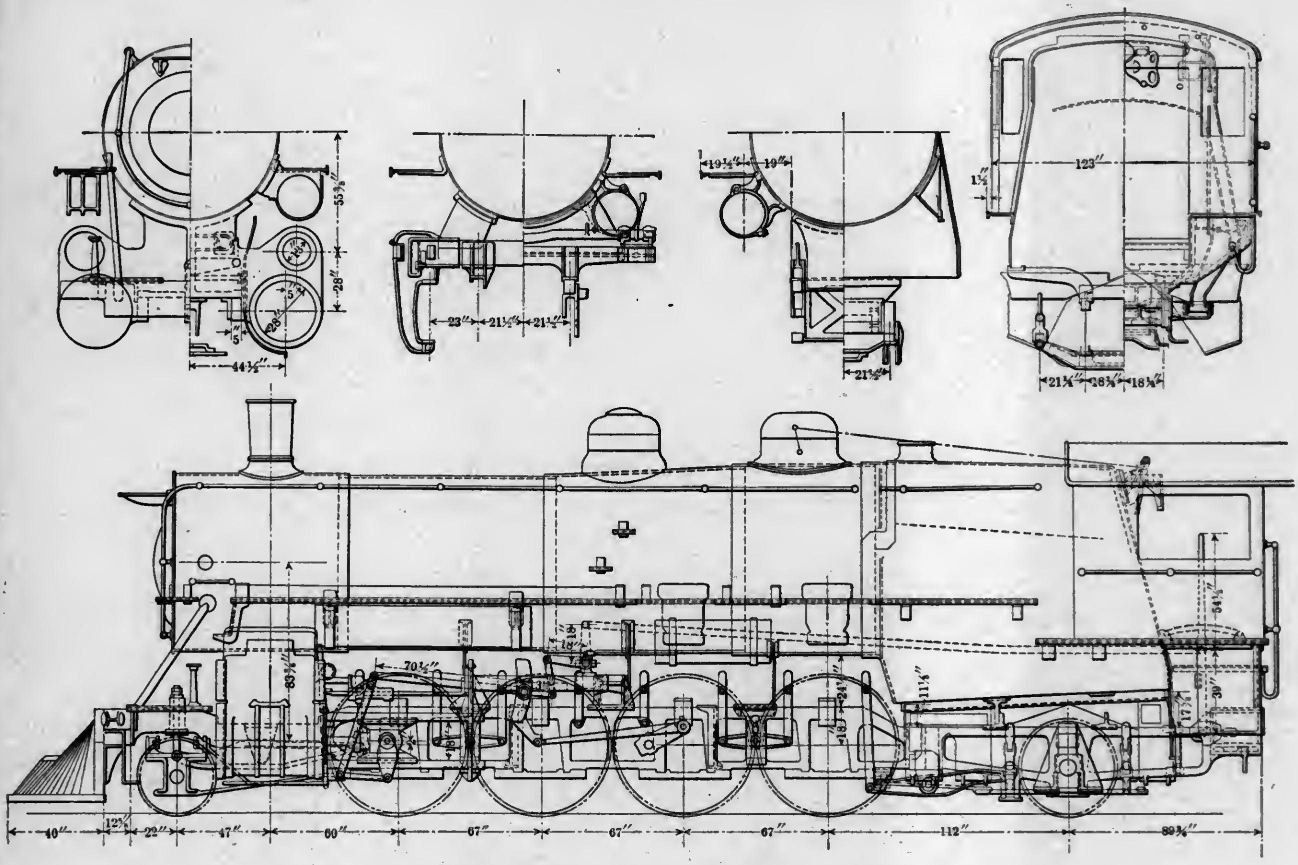


VERY POWERFUL LOCOMOTIVE EQUIPPED WITH EMERSON SUPERHEATER.

On the locomotives illustrated herewith, a boiler 82 in. in diameter at the front ring and 89 in. maximum diameter, having 21 ft. flues, and a grate area of 78.2 sq. ft., has been applied. It is fitted with an Emerson high degree superheater having 1,060 sq. ft. of heating surface and the pressure has been reduced to 170 lbs. This boiler is of practically equivalent size, but is of greater capacity than the one applied to the 2-6-6-2 type locomotives, of which there are 45 in service on this road. These locomotives were illustrated and described on page 213 of the June, 1907, issue of this journal. They were not fitted with superheaters, although a later order of the 2-6-8-0 type, considerably larger in size, were equipped with Emerson superheaters and also feed water heaters.

In accordance with the Great Northern Railway Company's practice, the boiler is of the Belpaire type and has both the crown sheet and outside roof sheets slightly arched. The water spaces at the mud ring are 5 in. in width, increasing to 6½ in. at the sides and 8¼ in. in the back water leg. In one of the illustrations will be seen the arrangement and location of the 5½ in. tubes enclosing the superheater elements, there being thirty of them. It will be remembered that the Emerson superheater employs headers somewhat similar in shape and location to the ordinary steam pipes. An improvement has been made in this application, in that the saturated and superheated steam chambers are in separate castings, which are bolted together, leaving an air space between. The bolt holes are sufficiently large to permit of movement due to the different ratios of expansion of the two sections. These headers connect to the steam passages in the saddle in the usual manner, but a 5½ in. pipe connects the two passages below the header connection, thus permitting the equalization of pressure and allowing each cylinder to draw on both superheater sections for its supply. The cylinders are 28 in. x 32 in., the walls being made thick enough to permit boring to 29 in. in diameter if desired. These cylinders are somewhat larger than the ones applied to the Illinois Central Mikado type, illustrated in the September issue, but in other respects the two designs are very similar. The Illinois Central engine having the Schmidt superheater of practically the same size is the Emerson applied here.

A novelty is found in this design in connection with the ash

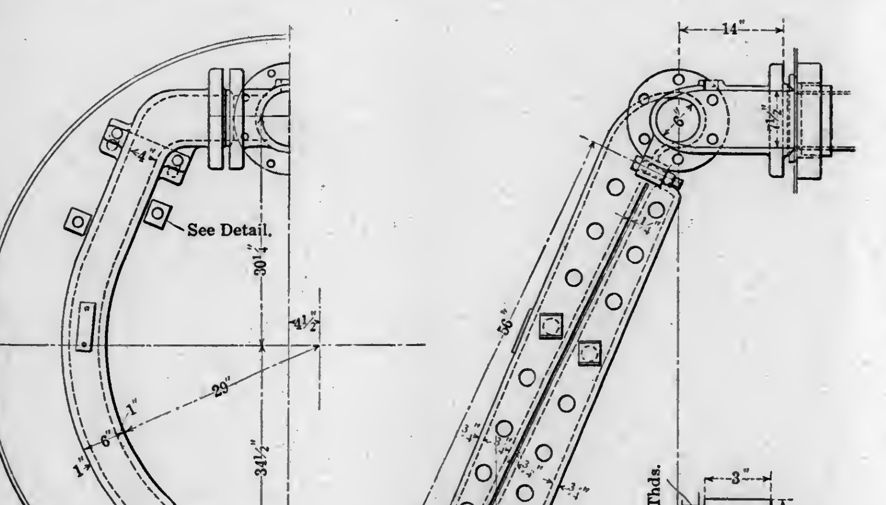


ELEVATION AND SECTIONS OF MIKADO TYPE LOCOMOTIVE ON THE GREAT NORTHERN RY.

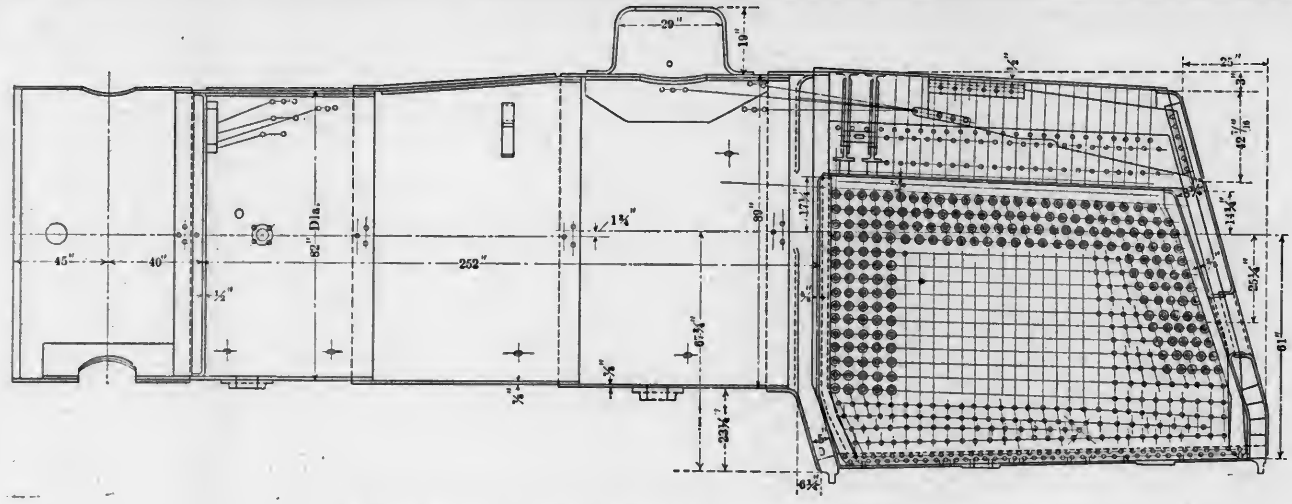
pan, which has six hoppers, all arranged to discharge outside the rail. The lower section of each of the hoppers is formed of cast iron plates and provided with a hinged door, the two forward ones being operated together from one gear, all operation being by hand. Details of this construction are clearly shown in the illustration. While this ash pan probably does not have any greater capacity than one discharging between the rails, it very completely fulfils the requirements of the ash pan law, as under no conceivable circumstances would a man have to get underneath the engine in cleaning it. It will be noted, however, that cinder pits having one rail on the outer wall of the pit would not be suitable for use with this pan.

In other particulars there is little of novelty in connection with the details of the design. It will be noted that the front frames are integral with the main frames, the slab being 5 in. in width and 11 in. deep. The driving boxes are of cast steel faced with babbitt, the wheels have no hub liners. The side rods are rectangular in section and castle nuts are used throughout all the motion work. It will be noted that the throttle rigging is outside of the boiler, the lever being in a vertical position on the back head and connecting to an arm on the horizontal shaft projecting out through a stuffing box in the side of the dome.

The tender is designed in accordance with the Great Northern standards and has equalized pedestal trucks and 12 in. steel channel frame placed unusually low. This lower center of gravity has been obtained principally by a special design cast steel truck bolster. In the coal space, a coal pusher arrangement has been provided, the general features of which are shown in one of the illustrations. This consists of a hopper of a shape and size to closely fit the space in the tender from the bottom of the slope sheet backward, being hinged at the forward bottom end, but not otherwise connected to the

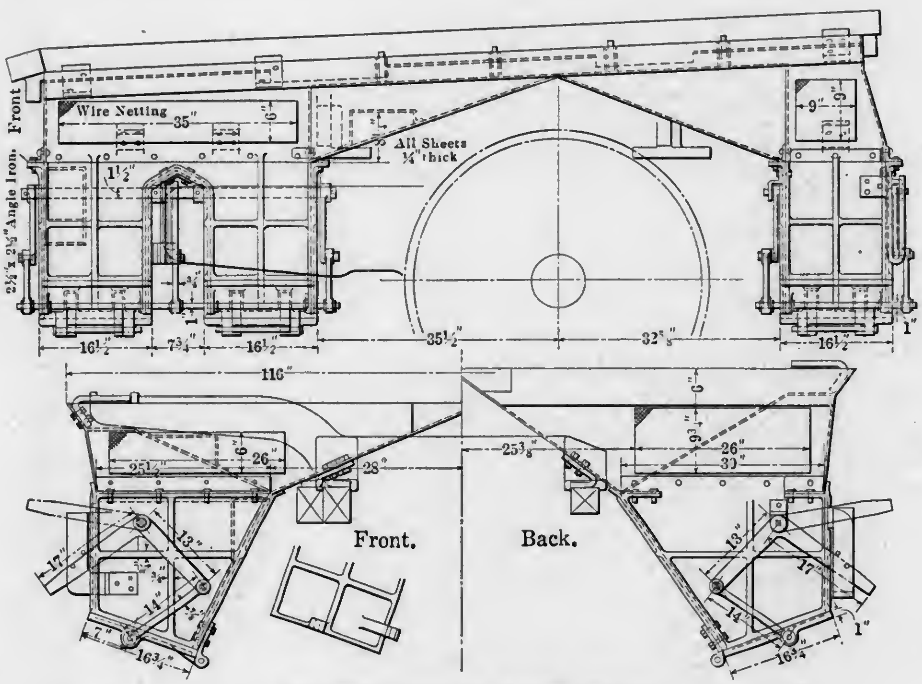


DETAIL OF EMERSON SUPERHEATER HEADER.



BELPAIR BOILER ON GREAT NORTHERN 2-8-2 TYPE LOCOMOTIVES.

tender. Near the back end of this hopper and on the center line there is a cast iron cylinder, extending vertically through the water space, in which there is a trunk piston with a connecting rod secured underneath the coal hopper. A 1¼ in. steam pipe connects to the bottom of this cylinder, and when steam is admitted, the whole hopper is lifted, swinging around the hinges at the forward end, and the coal slides forward, the amount of the lift, of course, depending upon the length of time the steam pressure is supplied. In this manner, all the coal in the space is brought to a convenient location for the fireman without extra labor on his part.



SIX-HOPPER ASH PAN OF NEW DESIGN.

The general dimensions, weights and ratios of these locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	57,500 lbs.
Weight in working order, estimated	287,000 lbs.
Weight on drivers, estimated	220,000 lbs.
Weight on leading truck, estimated	27,000 lbs.
Weight on trailing truck, estimated	40,000 lbs.
Weight of engine and tender in working order	435,000 lbs.
Wheel base, driving	16 ft. 9 in.
Wheel base, total	35 ft.
Wheel base, engine and tender	68 ft. 2 in.

RATIOS.

Weight on drivers ÷ tractive effort	3.83
Total weight ÷ tractive effort	4.98
Tractive effort × diam. drivers ÷ heating surface*	572.00
Total heating surface* ÷ grate area	81.00
Weight on drivers ÷ total heating surface*	34.70
Total weight ÷ total heating surface*	45.40
Volume both cylinders, cu. ft	22.80
Total heating surface* ÷ vol. cylinders	278.00
Grate area ÷ vol. cylinders	3.44

CYLINDERS.

Kind	Simple
Diameter and stroke	28 x 32 in.

VALVES.

Kind	Piston
Diameter	13 in.
Greatest travel	6 in.
Outside lap	1⅛ in.
Inside clearance	0 in.
Lead	3-16 in.

WHEELS

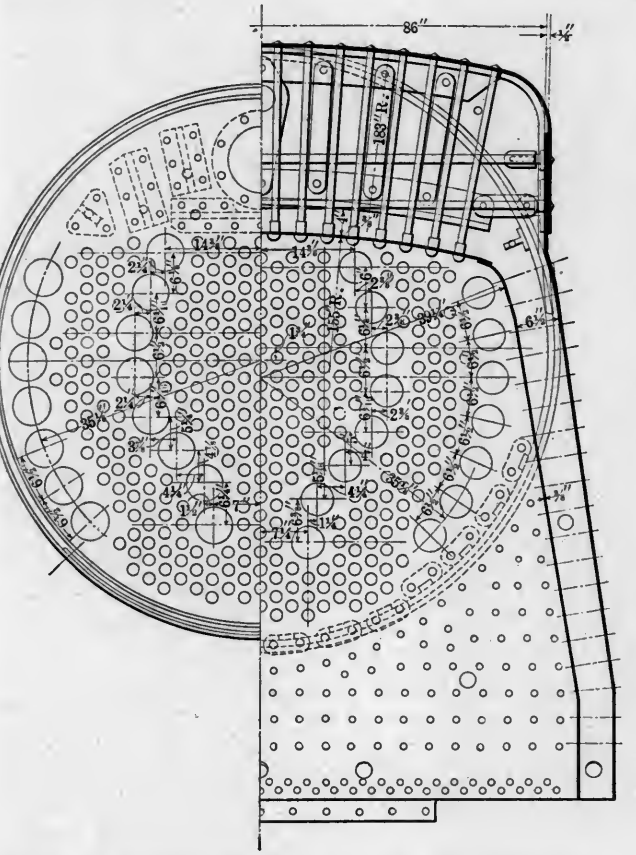
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	42½ in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Belpair
Working pressure	170 lbs.

* Equivalent heating surface = 6,310 sq. ft.

Outside diameter of first ring	82 in.
Firebox, length and width	117 x 96 in.
Firebox plate, thickness	⅜ x ⅝ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	30—5½ in.; 326—2 in.
Tubes, length	21 ft.
Heating surface, tubes	4,471 sq. ft.
Heating surface, firebox	249 sq. ft.
Heating surface, total	4,720 sq. ft.



SECTION OF BOILER SHOWING ARRANGEMENT OF SUPERHEATER TUBES.

Superheater heating surface	1,060 sq. ft.
Grate area	78.2 sq. ft.
Center of boiler above rail	117 in.

TENDER.

Tank	Fitted with coal pusher
Frame	Steel
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons

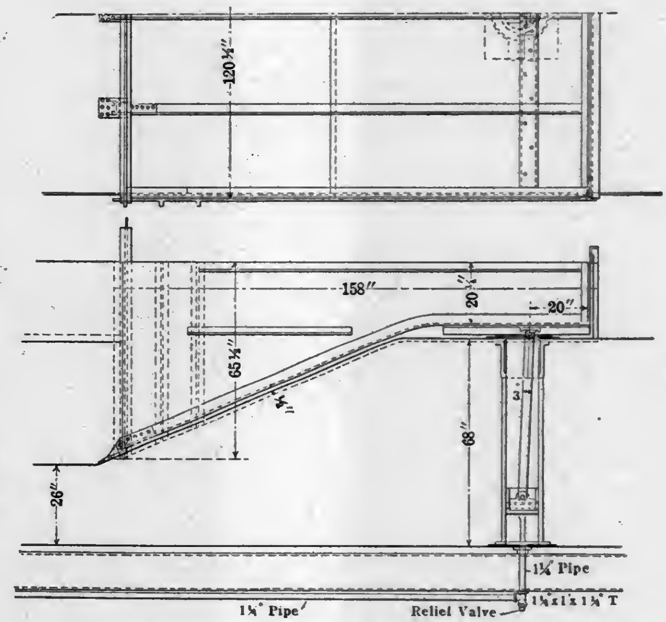
ELECTRIC LOCOMOTIVES FOR PANAMA CANAL

These unique engines for which it is understood bids have been asked for will in many respects become the greatest novelty on the waterway. Four of them will be required to tow a vessel of moderate size, two ahead (one on either wall) and two trailing behind to keep the vessel in the middle of the lock and bring it to a stop when entirely within the lock chamber. Each locomotive will consist of a body and two trucks, the body containing a motor-driven windlass for hauling in or paying out the tow line under load and a high-speed motor-driven attachment for coiling the line when it is out of service. The windlass drum will be fitted with a friction device to prevent the load on the tow line exceeding 25,000 lbs. This body will be supported by a partly flexible connection at each end on a truck. The two trucks will be identical, each containing traction motors and control apparatus.

When towing or taking the inclines between the locks, which are quite steep, the locomotive will operate as a rack-rail tractor, being propelled by the traction motors driving the rack pinions through gearing. These rack pinions will be of the quill-construction type and mounted on the back axle of the truck, allowing the truck wheels to run free. The towing speed will be 2 miles per hour. In returning, except on the inclines between the lock levels, the locomotive will travel under friction tractive effort at about 5 miles an hour, this change of speed being provided for by throwing in jaw clutches connecting the wheels of the trucks with the traction motors. The motors are required to have brakes able to stop them in 15 revolutions when running at full speed. The trucks will travel on a 5-ft. gauge track; the inclines between lock levels have a grade of 1 on 2, with vertical curves of 100 ft. radius, and the horizontal curves are of 200 ft. radius.

The motors for traction purposes are required to have a full-speed torque of 840 lbs. at 1-ft. radius and a full-load speed of not less than 470 r.p.m., and must be capable of developing at least 75 per cent. greater torque for a period of 1 minute. The motor for the windlass must have a full-speed torque of 120 lbs. at 1-ft. radius and a full-speed load of 660 r.p.m., and be capable of exerting 50 per cent. greater torque for 1 minute. The motor for coiling the cable is much smaller. All of them are to be three-phase, 25-cycle, induction motors of the railway or mill type. Current will be taken from a conduit containing two conductors, the third phase being carried by the two track rails.

The American Railway Association.—The fall session will be held at the Blackstone Hotel, Chicago, Ill., on Wednesday, November 15, at 11 A. M. Reports will be presented by the following committees: Executive Committee; Committee on Transportation; Committee on Maintenance; Committee on Relations between Railroads; Committee on the Safe Transportation of Explosives and Other Dangerous Articles; Committee on Electrical Working, and Committee on Nominations. Three members of the Committee on the Safe Transportation of Explosives and Other Dangerous Articles, two members of the Committee on Electrical Working and two members of the Committee on Nominations are to be elected at this meeting.



COAL PUSHER ON TENDER OF MIKADOS—G. N. RY.

In Order that the Entire Baltimore and Ohio system may benefit by the tests and experiments made on fuel coal a fuel bureau has been organized in the office of the general manager to conduct experiments based on the performance of all classes of locomotives in both passenger and freight service.

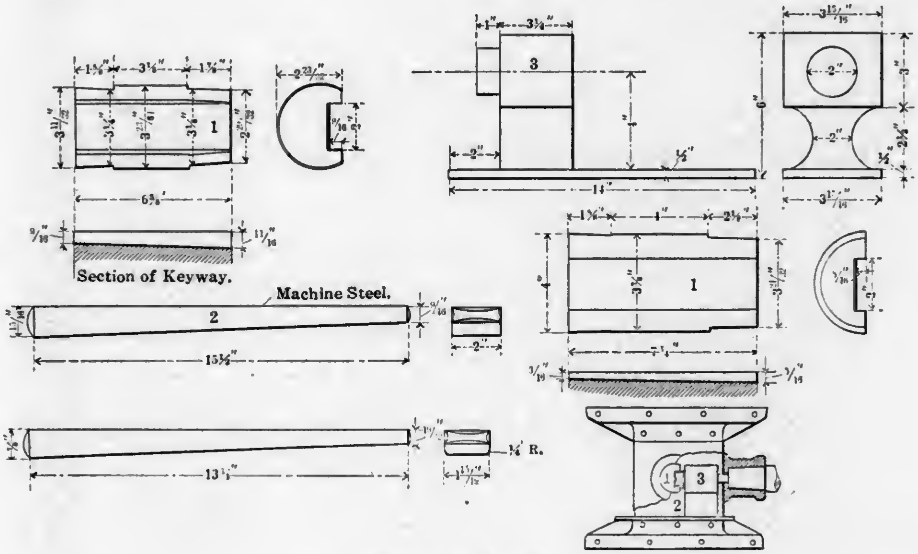
SOME NEW JIGS AND METHODS

CHICAGO & NORTHWESTERN RY.

Supplementing the shop devices used on the above road, which were described and illustrated in the preceding issue of this journal, those commented on below may be found of interest. It will be noted that they are of simple design, quite inexpensive and their construction indicates thorough efficiency for the various purposes intended.

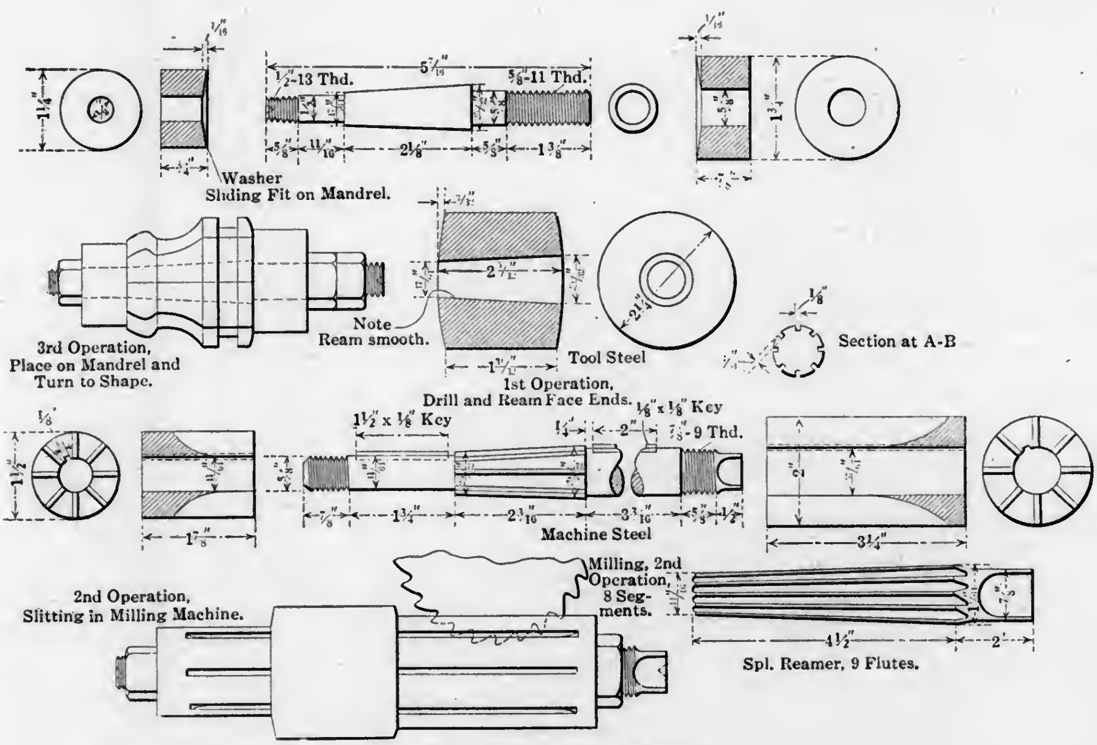
Great ingenuity is being displayed at the present time throughout the country generally in devices for the removal of piston rods from crossheads, and accordingly the one herein illustrated will repay examination as it is particularly applicable to alligator crossheads which are the prevailing type at present. The construction embodies an old wrist pin, planed on one side as shown in No. 1, and having a lengthwise keyway to receive the tapered key No. 2. A steel forging No. 3 rests on the top side of the bottom gib, and is so blocked up that the round boss on the end comes central with the piston rod in the crosshead.

To disconnect the latter parts the forging should first be placed as above indicated; the special wrist pin No. 1 applied and afterwards the key, when lightly tapped, will readily back out the rod without damage to it or the crosshead. In this connection it may be added that any device which will prevent burring or scarring these parts is worthy of a trial as they are accorded some rather rough handling on not a few roads where the piston pulling facilities are inadequate.



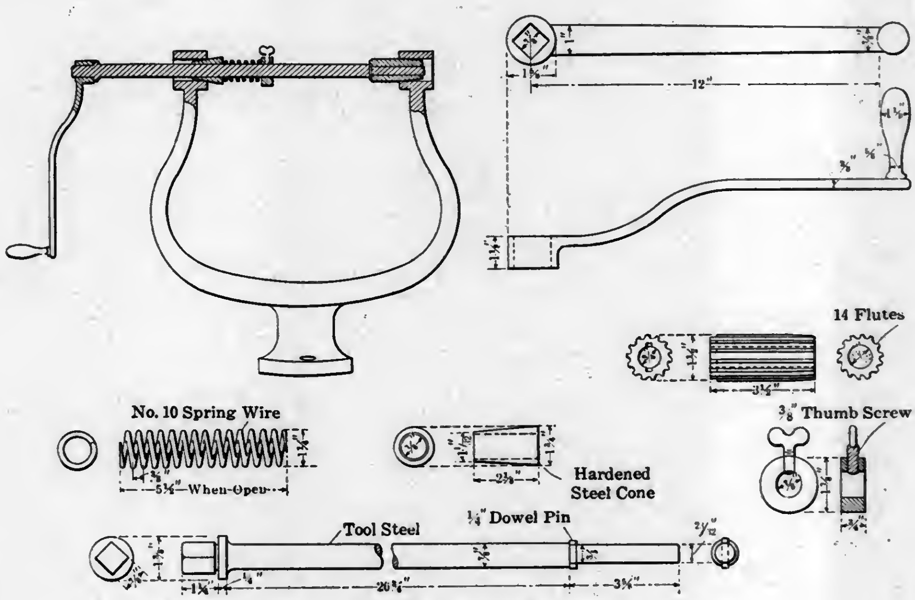
PISTON ROD REMOVER.

The jigs and tools for making flue expanders were designed by machinist Jensen, of the Clinton, Iowa, shop and are said to do very cheap and accurate work. The first operation is to drill and taper ream a piece of annealed tool steel of the required diameter and length. This reamer as shown is to ream the tapered hole. This piece of steel is slightly rounded on both



JIGS FOR MAKING FLUE EXPANDERS.

ends which fits the concave washers on the mandrels to hold the pieces together while being slit in the machine, as shown in the second operation. After the piece of steel is slit in eight equal pieces they are placed on the mandrel, as the third operation indicates, and turned up to a gauge which duplicates the section. The drawing is quite complete in detail and should



BELL YOKE REAMER.

give full information to those desiring to make flue expanders this way, without further explanation.

As practically all locomotive bells are now rung by air, and are in many instances constantly in use over the division, the wear to bell yoke pins and frame bearings is excessive. When renewals are required the bell frame in the majority of shops must be removed from the boiler to a drill press or lathe to line up the pin holes. It was found on the Chicago and North Western that this procedure was expensive and not always satisfactory, so one of its ingenious mechanics has designed the hand tools herewith illustrated which permit the work to be done on the engine in a few minutes.

The arbor is made of tool steel and is turned down on one end to receive the shell reamers which vary in size by thirty-seconds of an inch. The other end of the mandrel is squared to fit the crank or wrench to turn the shell reamer. The tapered cone is shown in position on the arbor, and held there by a coil spring. This arrangement ensures that this end of the arbor will be central and in line while the shell reamer is at work on the opposite hole. Conditions are simply reversed for either side of the yoke. This device is thought of very highly in the Clinton shop as a great labor saver, and one which insures round holes in perfect line with one another.

UNIVERSITY OF ILLINOIS STUDENTS

Registration at the University of Illinois began on September 18, and the work of the new year formally started on the 21st. The total enrollment of students on October 1 in the various departments at Champaign-Urbana was 3,620. Of this number, the College of Engineering is credited with 1,206, distributed as follows:

Architecture and Architectural Engineering	306
Civil Engineering	251
Electrical Engineering	290
Mechanical Engineering	275
Mining Engineering	21
Municipal and Sanitary Engineering	27
Railway Engineering	36
Total	1,206

LOCOMOTIVE FUEL OIL STATISTICS

No serious attempts were made in the United States toward using petroleum as a locomotive fuel until the Spindle Top field came in, when the Texas roads immediately took up the work of adapting locomotives to burn crude oil; the development of the California fields bringing the railroads of the Pacific Coast states into line as oil burners. The consumption of fuel oil by the railroads of the United States with the mileage figures as follows:

	Length of Mileage under Fuel Oil.	Total Mileage made by Oil Burning Loco.	Total Barrels Used.
1906	......	....	15,577,677
1907	13,573	74,079,726	18,855,002
1908	15,474	64,279,509	16,889,070
1909	17,676	72,918,118	19,939,394
1910	......	....	*23,000,000

*Estimated.

The mileage figures for 1906 are not obtainable, and those for 1910 are not yet completed, the consumption for 1910 being estimated and largely predicted on the increased consumption by the railroads of California oil which, for 1910 was 12,775,000 barrels, or 3,000,000 barrels more than was used in 1909. Out of 77,697,568 barrels of petroleum produced in California in 1910, a total of 50,720,000 barrels were used for fuel purposes, oil practically displacing coal as a railroad, steamship and manufacturing fuel on the Pacific Coast.

HARD STEEL IS NOW CUT WITH PLAIN DISCS of mild steel that are revolved at high speed. The discs are of boiler plate quality steel and about ¼ in. thick. They are revolved at about a speed of 20,000 ft. a minute. It is said that one of the discs will cut through a heavy channel section of hard steel, 12 in. by 6¾ in., in 15 seconds. The disc remains cool while cutting because of its large surface area and small point of contact. The metal cut also remains cool for a similar reason, although at the point of contact with the disc the temperature is very high. The explanation of this apparently wonderful feat of cutting steel with a smooth disc is that all the frictional energy of the disc is concentrated on an extremely small area of contact, and the cutting is accomplished apparently by local fusion.

STEEL CONTAINING OVER 20 PER CENT. of manganese is non-magnetic. A non-magnetic alloy is also produced by alloying 17 per cent. of aluminum with iron.

600 Ton Reinforced Concrete Coaling Station*

BALTIMORE AND OHIO RAILROAD.

A new reinforced concrete coaling station having a storage capacity of 600 tons and a hoisting capacity of not less than 125 tons per hour, has been designed and built by the Roberts and Schaefer Company, Chicago, for the Baltimore and Ohio R. R. Co., at Sir Johns Run, W. Va. There are two 2½ ton Holmen balanced hoisting buckets working in unison and traveling vertically from the bottom of bucket pit to the top of the hoisting tower and discharging automatically onto the chutes over the pocket. The pocket is arranged to deliver coal to locomotives on four tracks—two under and one on each side of pocket. The general layout of the station is illustrated on accompanying illustrations.

The receiving hopper is 20 ft. long and 15 ft. wide and built of plain concrete with well rounded valleys and corners, the surface being finished with 2 in. cement. The track stringers are 24 in. Bethlehem section connected with 15 in. channel separators and the rails are secured to the girders with special clips. In front of the receiving hopper are openings arranged with 2 Barrett self-operating revolving feeders to control the flow of coal and measure the quantity delivered to the Holmen buckets, thereby preventing waste of coal in the bucket pit. The base of rails of receiving track is 3 ft. 6 in. above that of coaling tracks.

Plain concrete mixed in proportion of 1 : 3 : 5 is also used for the bucket pit, which is 6 ft. wide and as long as the receiving hopper. The pit and the hopper are waterproofed on all sides up to 12 in. from the receiving track.

Under the pocket the main coaling tracks are 13 ft. apart while the outer tracks are 17 ft. from them on each side, in the center of which space rise the 2½ ft. concrete collision walls. The latter are 8 ft. high above the coaling tracks and go down into the ground 3 ft. Aside from the top and bottom there is no other reinforcement in the walls.

On the collision walls are erected the overhead coal pocket of 600 tons capacity. The pocket is 32 ft. wide across the tracks and 42 ft. in the other direction and reaches a height of 47 ft. above the base of rails. The head room under it is 21 ft. 6 in. while the clearance on each side of tracks is 7 ft. 3 in. There are four sets of undercut gates with heavy steel counterbalanced hooded aprons, one for each track, so arranged by counter hoppering that all coal in the pocket will be available with a minimum loss of space. The pocket is supported by seven columns on each collision wall, the five inside ones being 16 in. x 24 in. and two outside ones 12 in. x 24 in. The columns are reinforced with 1¼ in. rods, stiffened with occasional use of hoops made of ⅜ in. rods and designed to withstand not only the weight of coal and concrete, but to resist 40 lbs. wind pressure on the upper structure. The floor or bottom of pocket slopes on an angle of 40 degrees from the center to the walls over the columns and is built in one continuous slab from end to end, which is then counter-hoppered toward the openings. The slabs are 9 in. thick, including 1 in. sidewalk finish, reinforced with ⅝ in. rods, the end of which are bent up to resist negative moment at the supports. Additional rods are also provided to take care of shrinkage and temperature strain. Under the concrete slabs and between each two opposite columns is spanned a simple triangular truss with a hanger in the center and apex at the intersection of the sloping floors. On account of the enormous tensile stress coming onto the bottom chord of the truss, the method of securing the ends of the rods to the columns becomes an important factor. Also the fact that the intersection of the neutral axis of the top chord with the center line of the bottom chord is about 2 ft. away from the center of the column, multiplied the difficulties in reinforcing the ends of trusses. Great care was exercised in erecting the trusses to have the rods in the bottom chords tightly stretched before the concrete was placed in order to prevent cracks in the beams and possible deformation of trusses. The top chords are designed for both direct compression and flexure, the section being assumed as T-beams, as the floor slab undoubtedly comes into play to resist the combined stress above the neutral axis. The shear is taken up by bent up rods and closely spaced stirrups, as well as by the concrete itself.

The walls are divided into panels by means of pilasters, one over each column and at the center of walls across the tracks.

REINFORCED COALING STATION SERVING FOUR TRACKS.

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As the work on the pocket was to be done without interfering with the traffic on the main tracks, it necessitated construcing an overhead temporary structure to support the trusses, floors and a part of the walls and the forms. In order to accomplish this, 9 20-in. I-beams were swung across the tracks just below the bottom chords of trusses, leaving a clearance of 19 ft. above the rails.

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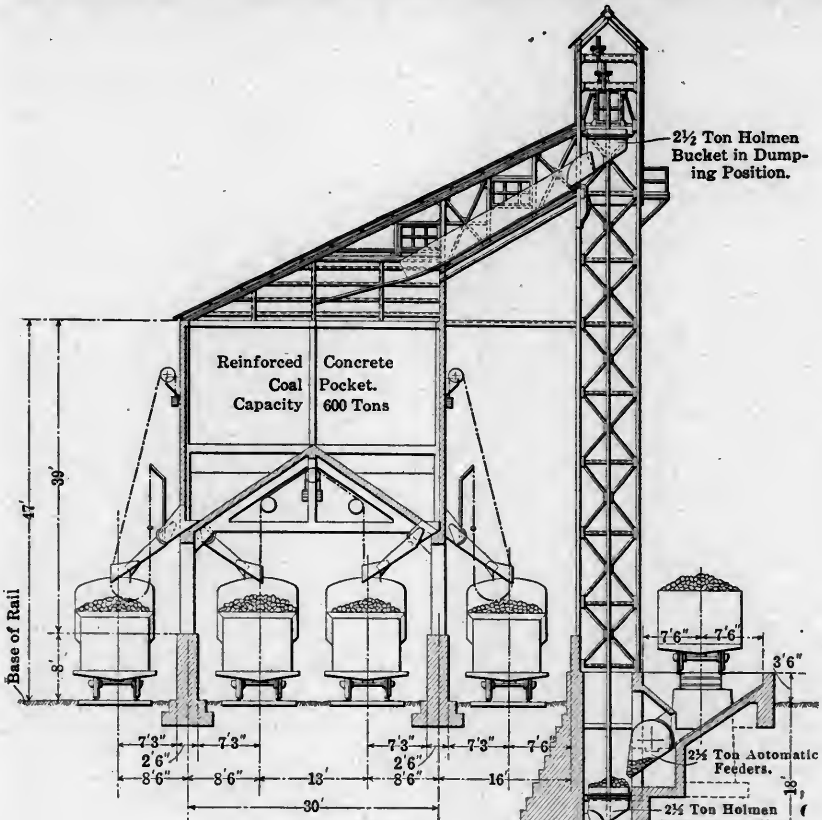

Cross Section.

PRIZES FOR GOOD TRACK

Fifty-four hundred dollars as prizes for maintaining sections of track in the best condition during the past year have been awarded by the Pennsylvania Railroad to supervisors and assistant supervisors. General Manager Long, with a party of about 200 operating officers of the Pennsylvania Railroad, made the annual inspection, and the prizes were awarded upon the return of the inspection party on October 4. The first prize, amounting to $800 for the supervisor and $400 for the assistant, awarded for maintaining the best section of track throughout the past year, was presented to C. M. Wisman, supervisor, and William F. Miller, assistant supervisor, who have charge of the track between Tullytown, Pa., and Deans, N. J.

Among the methods used to learn the exact condition of the "line and surface" of the main lines was to place glasses of water on the sills of windows on each side of the Special Inspection car at the end of a running train. Every "spill" of water occurring on each supervisor's section was carefully recorded as a demerit. There was also a machine on the floor of the car which recorded the jolts of the train from side to side and up and down. These records formed the basis on which the committee decided the prize awards.

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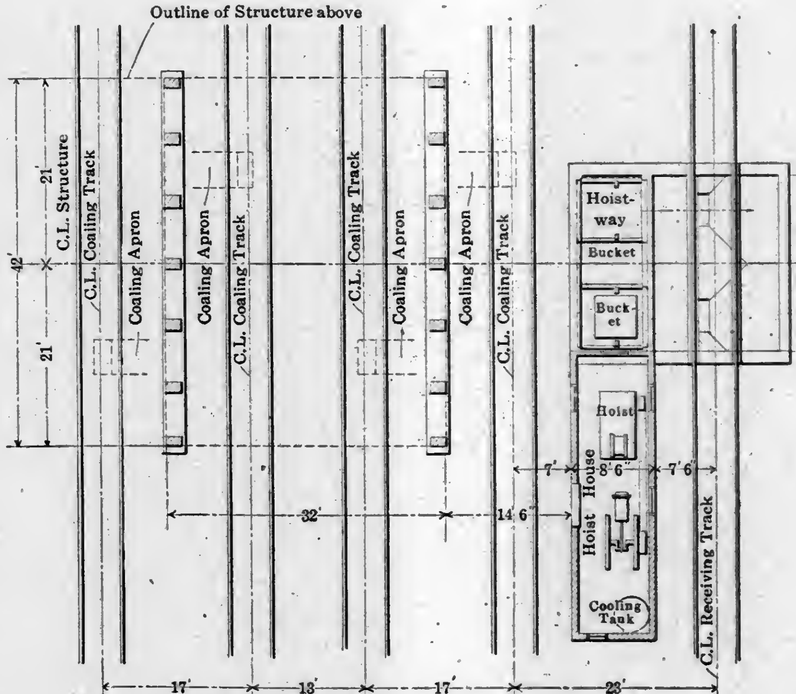
As is shown in the illustration, the hoisting tower is 7 ft. 6 in. by 18 ft. 8 in. in plan and 80 ft. high above the receiving track. It is built with substantial structural sections, cross-braced on four sides as well as on the inside bents and rigid enough to withstand the strain from live load due to the traveling buckets and 40 lbs. wind pressure on the exposed surfaces. The canopy over the pocket and the bridge from the tower are also steel framed and covered like the upper portion of tower, with American Ingot Iron on the walls and Carey's Magnesia Composite on the roofs laid on 1 in. roof boards.

The hoist house is located next to the bucket tower even and level with the top of receiving hopper. It is built with reinforced concrete throughout and equipped with 20 h.p. Ohio gasoline engine with Roberts and Schaefer Co.'s standard reversible hoist, a cooling water tank and service stop to prevent overwinding of buckets.

After a short experience with this coaling station, the B. & O. R. R. Co. awarded a contract to the Roberts and Schaefer Co. for three duplicates which are now under construction at La Paz Junction, Ind., Warwick Ohio, and Rowlesburg, W. Va.

The Largest Cantilever Crane in the world, recently made by a British firm for a Japanese dockyard, is capable of dealing with a load of 200 tons at a radius of 95 ft. A still larger one is now being built for the Japanese navy, to have a load capacity of 200 tons at 105 ft. radius.

Abandoned Railroads.—Records for 1910 show that in the United States there are 81 abandoned railroads. From 18 the rails have been removed, and 34 are described as "not in operation" or "operation suspended." In regard to the first class, the franchises seem to have expired by disuse, but the tracks are still in evidence. In the second class, the companies have pulled up stakes and quit. In the third, a variety of causes may have contributed to the stopping of wheels.



General Ground Plan.

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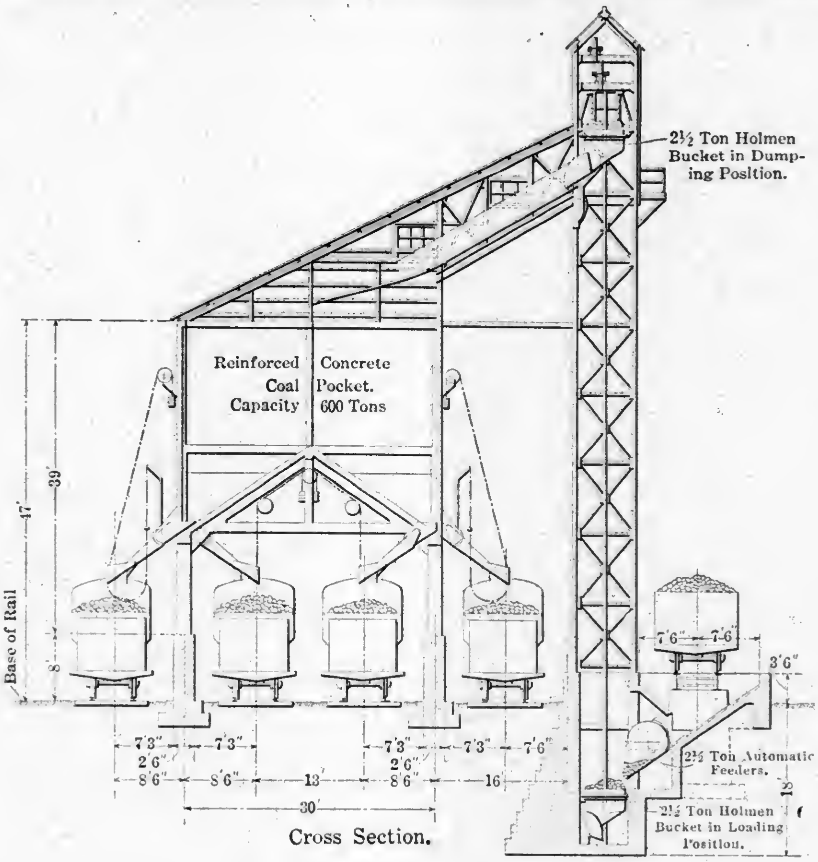

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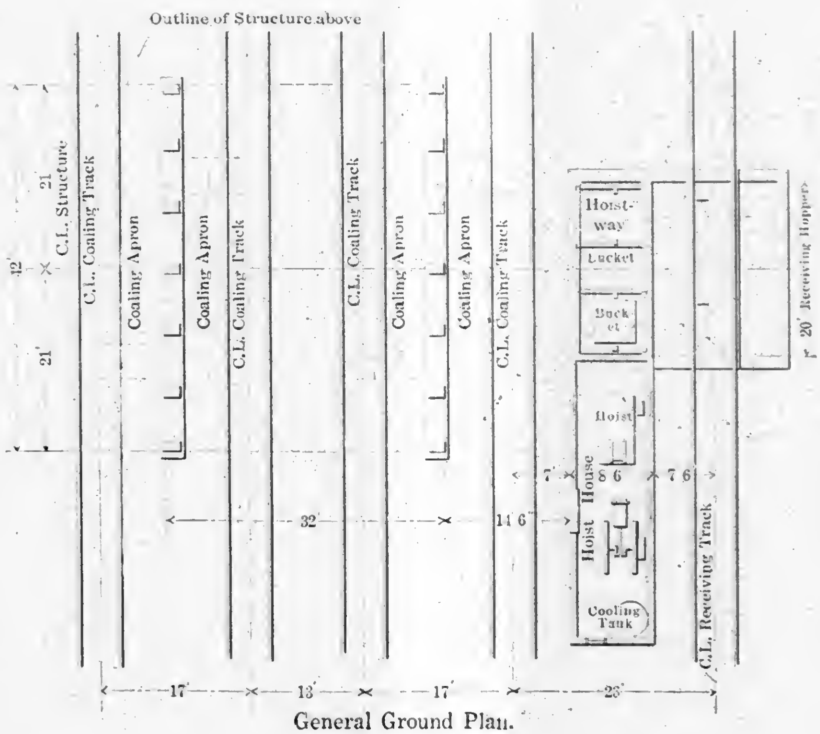
THE LARGEST CANTILEVER CRANE in the world, recently made by a British firm for a Japanese dockyard, is capable of dealing with a load of 200 tons at a radius of 95 ft. A still larger one is now being built for the Japanese navy, to have a load capacity of 200 tons at 105 ft. radius.

PRIZES FOR GOOD TRACK

Fifty-four hundred dollars as prizes for maintaining sections of track in the best condition during the past year have been awarded by the Pennsylvania Railroad to supervisors and assistant supervisors. General Manager Long, with a party of about 200 operating officers of the Pennsylvania Railroad, made the annual inspection, and the prizes were awarded upon the return of the inspection party on October 4. The first prize, amounting to $800 for the supervisor and $400 for the assistant, awarded for maintaining the best section of track throughout the past year, was presented to C. M. Wisman, supervisor, and William F. Miller, assistant supervisor, who have charge of the track between Tullytown, Pa., and Deans, N. J.

Among the methods used to learn the exact condition of the "line and surface" of the main lines was to place glasses of water on the sills of windows on each side of the Special Inspection car at the end of a running train. Every "spill" of water occurring on each supervisor's section was carefully recorded as a demerit. There was also a machine on the floor of the car which recorded the jolts of the train from side to side and up and down. These records formed the basis on which the committee decided the prize awards.

ABANDONED RAILROADS.—Records for 1910 show that in the United States there are 81 abandoned railroads. From 18 the rails have been removed, and 34 are described as "not in operation" or "operation suspended." In regard to the first class, the franchises seem to have expired by disuse, but the tracks are still in evidence. In the second class, the companies have pulled up stakes and quit. In the third, a variety of causes may have contributed to the stopping of wheels.



General Ground Plan.

A Railway Experimental Station

Has the locomotive testing plant at Purdue University produced any results of value to the railroads at large since its installation? Have such results from the Pennsylvania Railroad locomotive testing plant, as have been published, been of any value? Are the results from the brake shoe testing machine, the University of Illinois dynamometer car, the triple valve testing rack, and of many other special tests, returns of which have been given freely to all who have need of them, worth while? If so, why is it not possible to carry the same idea further and obtain equally valuable returns along other lines? Some of the universities, of course, are doing this in a small way, but their facilities will never permit them to operate on the scale that should be attained. The best results can probably only be presented by an experimental station wherein all railroad problems, so far as they can be handled in a properly equipped laboratory or testing station, established and operated under the direction of all the railroad companies through the American Railway Association or by the government through the Interstate Commerce Commission.

In the October issue of the *Engineering Magazine,* Benj. A. Franklin discusses at some length what he calls "An efficiency experimental station for the railroads." While Mr. Franklin's idea is the establishment of such a station principally for testing out scientific management in the railroad field, it seems possible to so plan a station along the lines suggested which would be of equal or more value in investigating problems that are not usually associated in the minds of most people with scientific management, although probably the author in using this term includes in it everything which tends for greater efficiency, be it either design, material or operation.

There probably is no one field of activity in the country which is constantly engaged in experiments equal to the railroads. There is no activity which is so quick to accept new suggestions and give them a fair trial. Beyond doubt there is no business which is so open to the introduction of better methods that show the slightest indication of becoming eventually profitable. Experiments, however, are always costly and in the way necessity compels them to be carried out on most roads, they are considerably more costly than would be the case under more favorable surroundings. In a great majority of cases, particularly in the smaller things, the present method is the only satisfactory one. But, on the other hand, in many of the larger features satisfactory conclusions are almost impossible because of the many uncontrollable affecting conditions, and it is these problems which, because of the probability of doubtful conclusions and the knowledge of the enormous expense involved, most of the railroad companies hesitate to undertake; that the co-operation scheme suggested seems best suited to solve. Scientific management in its narrow meaning is, of course, one of the most important of these and in its broad meaning includes many of them.

We give below abstracts from Mr. Franklin's article which make clear the nature of his suggestion, and also criticisms of the plan by several more prominent operating officials and others which were published with it:

Investigations and experiments cost money. Attainment costs much money. If every railroad is to make the investigation and experiment separately, starting with no data and no experience, the attainments will necessarily be varied. Some will record failures. Many will not start until others have finished. Many will give up the experiment in its progress. Some will attain success. But in the aggregate, under such conditions, there will be the maximum of trouble and expense. Not that it wouldn't be worth while, even then.

There are, however, certain conditions existing with our railroads, the consideration of which may point to a more economical solution of the problem.

The needs of all railroads in the matter of operation have a great similarity, so that a solution of a general problem for one road points the way to a solution for the others.

The railroads are not essentially competitive. There is under normal conditions no business reason why any advantage of method one gains should not be free to all.

If, therefore, there are problems of improvement in shop and operative management to be worked out (and no experienced man, in or out of railroads, will deny that there are), why should the railroads all work them out separately, with a consequent waste of time and money?

If they should not, then we find ourselves arrived at a remedy. They must work them out all together, and perforce at a central experiment station maintained by and for all.

There is nothing radical in such a proposition, of course. The Government departments, agricultural and others, have removed the radicalism. There is nothing contrary to the spirit of the times in it. The spirit of the times moves toward centralization, and the law does not forbid it when in the general interest. It is not, indeed, contrary to the practices of the railroads themselves, since in their traffic and other associations they have met the problem in this very way.

The vital question, it would seem then, is whether such a proposition would be in the interest of economy and advanced practice. It would certainly seem that this would be the case, and perhaps a brief imaginative construction of such a station would help to bring judgment to the matter.

The railroads might form, under separate incorporation, a central experiment station, each road, let us say, furnishing capital upon some unit basis agreed upon as equitable to all, such possibly as car-miles. The amount of capital for this purpose need not be large—say $5,000,000, to be expended only for equipment.

The operating expenses could be met, at first partly, and eventually entirely, by charges for services rendered to the railroads, or they could be divided pro-rata yearly between the railroads. It would seem that they need not be large—let us say, $1,000,000 a year.

One of the valuable departments of such a station would be the repair shops. A large shop, of the size of the average railroad shop, run entirely in the interest of experiment, could furnish from itself alone values to the railroads entirely compensating for the expenditure. The railroads could furnish it ample work in locomotives and cars to be repaired, to be charged for, of course—a first source of income.

It would seem necessary that the employees of such a shop should have no entangling alliances that would prevent their working strictly in the cause of the advancement. It does not seem that it would be a difficult proposition to man such a shop with independent and skilful men, and the opportunity for technical-school and college graduates here would be valuable both for themselves and the station.

Here, then, could scientific management find its entry properly into the service of the railroad. Here could be developed that functional form of organization which in studying, in planning, in preparing the way for, and the equipment of, the army of workers, and in instructing them, could, without doubt, lead to the aid of the railroads an effective efficiency which they neither now possess nor indeed believe possible. The railroads must see to believe. Here could be developed the object lesson.

Here the organization and methods of scientific management could be developed in relation to this work, and the practice perfected. From this station could go forth experts who would develop it in the railroad shops. In this latter work, of course, the trade unions would have to be reckoned with; but there is very much in the methods of scientific management to which the unions can at present offer no objection, and education in these matters will eventually lead them to accept the features of reward for efficiency, which now find small favor with them.

From such a shop there should issue constantly valuable results of experiments covering the whole range of shop practice—the efficiency of tools, the best tools for given purposes. Indeed, would it not pay the tool manufacturers to supply their tools to this station free of charge? Records of operation costs on standard operations sent to the railroad shop would have a stimulating result. The best methods of repair, the most economical, efficient repair, and indeed innumerable economical results, must necessarily emanate from such a shop once it is organized under an efficient head.

But the repair shops would necessarily be only one department of this central experimental station.

There would haply exist an operating department of sufficient force and equipment to make vital experiments in economy of operation, coal values, roundhouse practices, periodical necessities of engine overhauling, equipment, preservation, etc. It goes without saying, of course, that in all departments of such a station experiments with new inventions to discover their real

values of service and economy to the railroads would find a decidedly legitimate place.

Similarly, there would be established departments of experiment along other lines of railroad activity. Some of the departments, such perhaps as that of statistics, would find in this central station only headquarters, while through experts to study, and later to install, it might evolve not merely vital and valuable statistics, but—what would be very much to the point in railroad work, where clerical labor is a large item of expense—it might develop a much greater simpliciy of records and a higher quanity standard of efficiency when the method was fixed upon.

Given, then, this central station equipped and organized with the necessary departments, it would be able to call to its aid from time to time experts from outside to suggest, to aid, and to formulate; and, of course, it is almost needless to say that the talent active on the railroads themselves would be essential in co-operation.

Once well started, such an experiment station would of course be held accountable to attain and formulate definitely practices for improvement of any and all railroad problems in a practical way, and to report them in an understandable manner to all the railroads. But more than this, it must also be prepared through its experimenters to install in a diplomatic and successful manner, upon request, any methods so reported. Indeed, a natural consequence of such a station would be that the experimenters would necessarily spend much time within the railroads outside of the station, and both an advantage to the railroad and a danger to the station would be the abstraction of these experimenters by the railroads for practical service.

Such, in the rough, is a plan whereby the railroads with similar problems and needs, and the strong necessity for economy and organization of the highest order, and subject to rapid developments, might well operate to bring about these elements of improvement with the minimum of expense and the maximum of efficiency and rapidity.

To recapitulate:

The railroads have need of economy beyond the ordinary industry, because of their direct public service and the Government control of rates.

Their widely spread area of operation and multifarious activities make them the sure prey of waste of labor and material, except under the most scientific development of organization and management.

Their problems of operation bear such a similarity to each other on all roads as will permit of single solutions for all alike.

They are not essentially competitors, and consequently there exists no business reason why the advantage of successful experiment should not be free to all.

The spirit of the times and the law of economy call for centralization of experiment for better methods.

A central experiment station could work out, in a comparatively short time, a successful solution of very many railroad problems.

Such a plan would bring about the use on all railroads of many practical and highly economical methods, much in advance (in point of time and perfection) of their present likelihood of adoption. Such a plan would save much duplication of experiments involving useless expenditures and variations of results.

It is not improbable, indeed, that some such plan has rested in the minds of many who have a genuine interest in the matter. Such a plan operated by the railroads and in their interest solely, with money furnished by them, would eventually meet from the railroad a practical and rapid co-operation, such as it is not in the nature of things would be forthcoming to any like ideas offered from outside sources.

Provided all other obstacles and objections are met, can the railroads who have proven their ability to co-operate with each other in lobbies, in rate fixing, and in matters that deal with external affairs, get together on such a plan as this, which would deal very intimately with internal affairs?

COMMENT ON THE SUGGESTION.

E. P. Ripley, Pres. Atchison, Topeka & Santa Fe Railway, doubts the efficiency and value of such an experimental station, stating that we already have thousands of students in mechanical matters in our schools and universities, and each road has scores of the graduates of these institutes, each one animated by a personal ambition to discover something better and cheaper than the ways now used. He states that he believes that there is now ample opportunity for the development of any new idea that promises well. That there are great wastes in the business is admitted, but it is charged that these are economic wastes largely due to the attitude of the government which compels their continuance. Mr. Ripley concludes his statement by stating that while very much could be accomplished by co-operation among the railways in many ways, he is convinced of the general futility of the plan proposed.

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Julius Kruttschnitt, Director of Maintenance an Operation of the Harriman Lines, discusses the subject at some length to indicate the weakness of the suggestion. His comment is in part given below:

A mere enumeration of the principal elements of efficient railroad operation will show the impracticability of reproducing actual operating conditions in an experimental station.

The first and foremost efficiency factor is *car and train loading;* given this, we have as a close second *train movement* that wastes neither power, by light movement of cars and locomotives, nor labor, by delays and consequent overtime payments.

Following these are:

Efficient consumption of fuel in the locomotive—a very different matter from its consumption in a laboratory or stationary boiler.

Handling foreign freight cars to avoid rental payments when idle.

Water purification.

Use of lubricants.

Shop practices.

Preservation of timber from decay, and from crushing under rails.

Rail and rail-joint design, and chemical composition.

Receiving and delivering freight.

Track and bridge maintenance practice.

Design of locomotives and cars to fit service conditions.

Although Mr. Franklin's suggestion is broad enough to embrace all railroad operations, it seems directed principally to possible economies in the *shop* practices of railroads, an important and expensive branch of the service, but by no means controlling in efficient operation. Maintenance of the equipment of the roads of the United States at the present time costs three hundred and sixty-four million dollars annually, or 22.75 per cent. of the operating expenses. Of this amount approximately 50 per cent. was paid for material and charges which cannot be altogether controlled by the railroads, so that the amount on which economies are mainly to be effected is one hundred and eighty-two million dollars, or 11.4 per cent. of the operating expenses. A loose estimate, made before the Interstate Commerce Commission,, of possible economies in shop practice, of a million dollars a day, or three hundred and sixty-five million dollars per annum, was immediately accepted as proven, and has since passed current at its face value. Whilst not altogether true, or fair to the railroads, it has unquestionably prompted study on the part of railway managers, and Mr. Franklin and the public can hardly be blamed for misunderstanding the situation.

Whilst the efficiency with which a railway is managed must be gauged by the results produced by the plant as a whole, no one will deny that some parts of it are not worked to maximum efficiency. It can be shown that the average number of passengers per train is much less than the average train can accommodate; that the amount of mail handled per postal car is much less than the capacity of the car, and that the average freight train hauled by locomotives is much less than their potential hauling power. Whilst it thus may be easily demonstrated that the maximum *possible* efficiency with which direrent parts of the railway plant might he operated under *ideal* conditions is not attained, it is much harder to show that the maximum *practicable* efficiency under the conditions which exist and with which railway managers have to deal, is not approached. The railway manager has not, never had, and never can have, the same degree of control over the operation of his plant, and of each part of it, that the manager of a mercantile or manufacturing concern may exercise. Shippers demand, and properly, that freight shall be transported with regularity and expedition, and speedy and regular transportation is an important element in efficiency of operation. But it is often not practicable to move freight with the maximum speed and regularity obtainable and at the same time hold cars and engines at terminals until the maximum car and train loads can be procured. The railways might easily haul a much larger average carload of mail, but under postal regulations mail carloads are limited to about three tons, whereas express cars are loaded to the roof with twenty to thirty tons of express. Again, in passenger service, the reason why the railways average only fifty-four passengers per train when the average train has a capacity of at least one hundred and fifty passengers, is that the public demands, and properly, that it be given frequent and regular service, and frequent and regular service is incompatible with the maximum loading of trains.

The facts cited illustrate a point generally overlooked in discussions of railway efficiency; that is, that efficiency from the standpoint of the railway is often not the same thing as efficiency from the standpoint of the public. Efficiency from the railway standpoint may consist in loading cars and trains to their ca-

pacity and moving the minimum number of cars and trains to handle the business; it may involve a relatively slow speed, because the faster engines are driven, the greater amount of fuel they consume and the smaller the load they can pull, the result being that the cost of running the train is increased while the revenue derived from running it is reduced.

Now, when the public insists on a kind of transportation which is incompatible with the most economical operation, no one can justly criticise the railway managers for complying with the public's demands, and thereby failing to operate the properties with the maximum possible economy. If railway managers operate the properties, not with the maximum economy possible under certain *conceivable* conditions, but with the maximum economy practicable under *actual* conditions, they do all that can be reasonably asked of them. I think that the railways of the United States are operated much closer to the maximum *practicable* efficiency and economy than most people believe.

Far be it from me to depreciate efficient management in any department; but what I do wish to emphasize is, that much work is performed in an apparently wasteful manner on railroads because it is impossible to do otherwise and still give desired service. Equipment repairs cannot be concentrated in specially designed central shops; much of it has to be repaired in yards, and on sidings at outlying points, where special facilities cannot be provided. On one large system the general shop payroll is only one-fourth of the total shop payroll. If this proportion holds on all the railroads of the United States, that part of the $182,000,000 paid for labor that could be brought under scientific management is reduced to a very small part of the whole. The zeal with which the people enforce their will in regulating railroad operation, requiring damaged locomotives and cars to be cut out of trains on the spot—shop or no shop—with men and material for repairs to be provided regardless of distance, has aggravated the dispersion of repair forces, and has weakened supervision. In other railroad departments the public prescribes the hours of employment, and in many States, besides holding railroads strictly accountable for damages resulting from accident, the number of employees on trains is fixed regardless of economy or efficiency.

Efficient tools, shop appliances, and methods are not unknown to railway managers, many of whom are using the best of their kind; but here, as elsewhere, they can never afford to forget the paramount nature of their duty to the public.

The opposition of organized labor to more efficient methods is so well known that I need not emphasize it, but I may be permitted to explain the exceptional nature of this handicap, to the railroads. The manufacturer, with no obligations higher than those to his stockholders, can demand the most efficient service of his employees, enforcing his demands by dismissal or even by stopping operations and closing his factory. The pubic, however, demands that the railroads perform their duties, regardless of handicaps, and forbids them, under severe penalty, to lighten their burdens by combination or agreement; but with singular injustice and inconsistency permits, and even encourages, part of the public, through organization and combination, to embarrass, coerce, and, to a large extent, control railroad operations to suit themselves. In the event of a strike the public is almost invariably found on the side opposing its own servants.

Most large railroad systems have bureaus for inspecting, and plants for testing materials, and are at all times making experiments to promote economy and efficiency. The results are freely exchanged, so that I do not see what benefits, that are not now enjoyed, would be obtained from a central experiment station.

To recapitulate:

1. The railroads owe their first duty to the public and, if necessary, economy and efficiency in some departments must be sacrificed to attain efficiency of the railroad as a whole.

2. Their widely spread areas of operation make railroads unusually subject to waste. Therefore, most careful supervision is necessary.

3. Realizing the nature of their duties to the public, the railroads, in yielding to the demands of organized labor, frequently sacrifice both economy and efficiency for the sake of industrial peace.

4. If a private corporation becomes involved in industrial war, the victims are its stockholders only; if a railroad becomes involved in industrial war, the victim is the public.

5. The problems of operation are *not* similar on all railroads, and general solutions are not possible. Differences in fuels, water, climatic and topographical conditions vary the problems of locomotive and car design, as well as shop practice.

6. The railroads are not competitors in methods, and no reason exists why the fruits of successful experiment of one road should not be shared by all.

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Harrington Emerson, in speaking on the subject, discusses at some length the principles of scientific management, particularly as applied to railroads. In speaking directly concerning the experiment station, he states "that five of the features mentioned by Mr. Franklin are axioms and that the sixth (a centralized experimental station could work out solutions), is also axiomatic but not exclusive, since there are other solutions than those of a central station. Admitting that a central station *could* work out a solution, *would it?*

In spite of their control by very able and exceptional men, enormous wastes occur in railroading. This must be due either to the men or the type of organization they work under. A foot walker, without bicycle, automobile or aeroplane, cannot make high speed, however athletic he is.

The minor ideals of railroading—economy and harmony—have been submerged by the greater ideals. The great railroad executives were generals, and great generals have always been wasteful and arbitrary. The men who could span the continent with rails and create an enormous traffic where none had been, who could regulate eighteen-hour trains between cities nearly a thousand miles apart, these men have not understood the principles underlying organization any more than they understood the principles underlying efficiency. As a consequence, as they themselves confess, their roads are dominated by labor combinations, and they accept wastes as inevitable.

If a railroad company cannot run a single one of its own shops economically, if each of a lot of railroads makes about all the mistakes possible in equipping and operating its shops, how can the executives of these roads organize jointly a model shop? They do not know how to do it individually, neither do they know how to select an independent executive who could.

There is a precedent for what ought to be done A generation ago, in the days of the Fisks and Drews, railroad accounting was unstandardized and vicious. At the whim of the executive (practices that lingered until railroad accounting was standardized by the Interstate Commerce Commission) operating expenses were capitalized, and *vice versa,* subsidiary accounts were skipped. Bondholders and shareholders lost all faith. A two-fold protection was ultimately evolved.

The issues of shares before they were valid had to be certified by an independent trust company, and the accounts had to be checked over and be verified by foreign chartered accountants, governed by principles and not amenable to local temptation or threats.

Accountants cannot, of course, check the efficiency of expenditures; they can only certify that certain rules governing expenditures and accounting have been observed.

Accountants certified to the Illinois freight-car-repair frauds. Bills for freight-car repairs were approved by the proper officials, they were charged to the proper account, and were therefore passed. Accounting professes to do no more. It cannot establish standards of expense, because this is as different an art from accounting as heaving the lead is different from calculating an eclipse. Even if standards are provided, accountants can only record, cannot enforce their attainment, because the enforcing of standards is as different an art from recording as dredging a channel is different from looking at the stars.

When I say that all the locomotives of a great railroad can be maintained for a cost of $0.05 a mile, it is not an answer to declare that no railroad succeeds in doing this, nor yet that any existing railroad mechanic finds himself unable to do it. The negative cannot be proved against me. The positive can be proved by me and by others who know. It is just as possible to set up a standard for each kind of operation, drilling, planing, turning, filing, fitting, shearing, punching, driving flues, as it is to set up standards of the shapes of the letters used in printing.

Every item of repair undertaken consists of a combination of the elementary operations, each with its standard time and cost determined and verified by experiment. All the separate items of repair at standard cost constitute the total standard cost for repair of a given locomotive; all the standard costs of all the repairs to all locomotives constitute the standard total repair cost for the year.

This would be laborious work. As to any road spending $5,000,000 a year in locomotive repairs, it might cost $100,000 a year for several years to establish, to attain, and to maintain standard costs, and save from one-third to one-half the repair bill. It is not at all necessary to take a year's time or $100,000. A qualified expert can go into any locomotive repair shop in the country, check up during a week fifty unselected operations, and show that the average time and cost of the lot ought to be reduced one-half. If given time to standardize both conditions and operations as to the items in question, the expert will reduce the time and cost one-half. This procedure has been gone through with over and over again in various locomotive building and repair shops, and over and over again the average efficiency has been shown to be as low as 50 per cent., and over and over again as to individual operations it has been brought up from 50 per cent. to 100 per cent.

Railroad wastes are like hygienic wastes. The latter are due to a great variety of causes—inheritance, unhygienic location, avocations, ignorance, indifference, the pressure of other and more powerful incentives. Norway has reduced its death rate

far below that of any civilized country, but first Norway realized the magnitude of the problem and put in a generation striving for its ideals.

Railroad wastes are like agricultural wastes.

Germany, in twenty-five years, has increased her output of staples per acre under cultivation between 30 and 40 per cent. Germany to-day averages per acre 100 per cent. more than is realized in the United States. The German agricultural society has been busy for twenty-five years.

When the whole country, governments, investors, executives, workers, patrons, communities, wake up to the fact that preventable railroad wastes aggregate more than two million dollars for every working day, that half this loss could be rather easily eliminated, certainly as easily as the increase of yield per acre and more easily than the lengthening of life in Norway; when it is realized that the cost of effecting loss elimination need not exceed five per cent. of the saving; when it is realized that the two-million-dollar-a-day gain will inevitably be distributed to those who do railroad work, to those who furnish railroad money and to those who supply railroad traffic—then, and not before, will the great problem be taken up seriously.

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Louis D. Brandeis favors an experimental station of the kind suggested, but believes that it should be undertaken by the government, advancing his argument as follows:

In view of the obligations already assumed by the Government in the regulation of railroad rates and service, it should be prepared also to lend its aid to the railroads in advancing efficiency and in securing to them greater justice by permitting them to enjoy earnings on capital in proportion to the efficiency of their management. To this end a great forward step would be taken if the Government should establish a Bureau of Railroad Costs and an Experimenal Station in Railroad Economies.

The railroads are the greatest single industry in the United States next to agriculture. The interest of the general public to secure efficient and economical transportation is so great that the Government would be fully justified in incurring any reasonable expense to aid in increasing railroad efficiency. The expenditure would be similar to that now incurred by it in aid of more efficient agriculture.

The simple ultimate unit costs of each operation in every department of every railroad ought to be ascertained. They should be properly supervised, analyzed, classified and compared, so that each railroad should have the benefit of knowing the lowest unit cost of each operation attained by any American railroad, and how it was attained. This information should be disseminated as the Government now disseminates other useful information through the various bureaus of the Agricultural Department, the Department of Labor and Commerce, and the Department of the Interior. There should also be established an Experimental Station in Railroad Economies.

Such a station could be conducted similarly to the present experimental stations in the Department of Agriculture which are so potent in raising the standard of agriculture in the United States.

The Government now undertakes, through its Bureau or Office of Public Roads, under the Department of Agriculture, to advance with excellent results road building throughout the United States. The co-operation of the Government in furthering improvements in railroading would be infinitely more effective. It would undoubtedly develop valuable inventions and discoveries in its own laboratories, as the various experimental stations of the Agricultural Department have done. But it would be of even greater service in testing the inventions made and methods suggested by others and bringing to the attention of the railroads those of especial value. There are undoubtedly in existence today hundreds of inventions of greater or less significance—hundreds of new methods which, if adopted, would enhance the efficiency of railroad operation, and introduce economies of wide scope, but which are not known to the operating men because no adequate means exist for bringing them to their notice, which are unused because no single railroad is willing to give the time or incur the expense of testing their value; or because the inventor or discoverer is unable to secure a hearing or trial. There are undoubtedly also a large number of devices and methods in use in foreign countries of which our railway managers have either no knowledge or have but inadequate information. It is a proper function of our Government to make such investigations and to give to the railroads and to the public the full benefit thereof.

An Approximate Rule for the length of belting is as follows: Add the diameter of the pulleys together, divide the sum by 2, multiply the quotient by 3¼ and add the product to twice the distance between the centers of the shafts. An even better rule than this is to cut out the figuring and use a tape line round the pulleys.

THE VALUE OF THE BRICK ARCH

What is probably one of the most valuable and accurate road tests of a locomotive ever made was conducted about a year ago on the Pennsylvania division of the New York Central & Hudson River R. R. under the charge of a committee which included representatives of the American Locomotive Co., Pennsylvania Railroad and New York Central. The tests were made on a 2-6-6-2 type Mallet locomotive and in addition to determining accurately the general features of this type of locomotive, the value of a high degree superheater, the brick arch and a locomotive stoker in this class of service were also investigated.

The Pennsylvania Railroad's dynamometer car was used and the greatest refinement and accuracy were present in connection with instruments used, methods followed and observers selected. Results of great value and interest were obtained, and in addition to these given below, it is expected that others will appear in these columns in future issues.

One of the most striking features developed during the tests was in connection with the fuel saving or capacity increasing value of the brick arch. The locomotive equipped with a superheater was operated on a number of runs without a brick arch and was then equipped with a "Security" arch and similar trips were again undertaken. The information thus obtained led the committee in its final report to the following conclusions:

"Data in reference to the performance with and without fire brick warrants the conclusion that the application of fire brick to this type of locomotive using this grade of fuel, may be expected to result in a saving of about 11 per cent."

An analysis of the coal used, of which there were two different grades, show approximately the following:

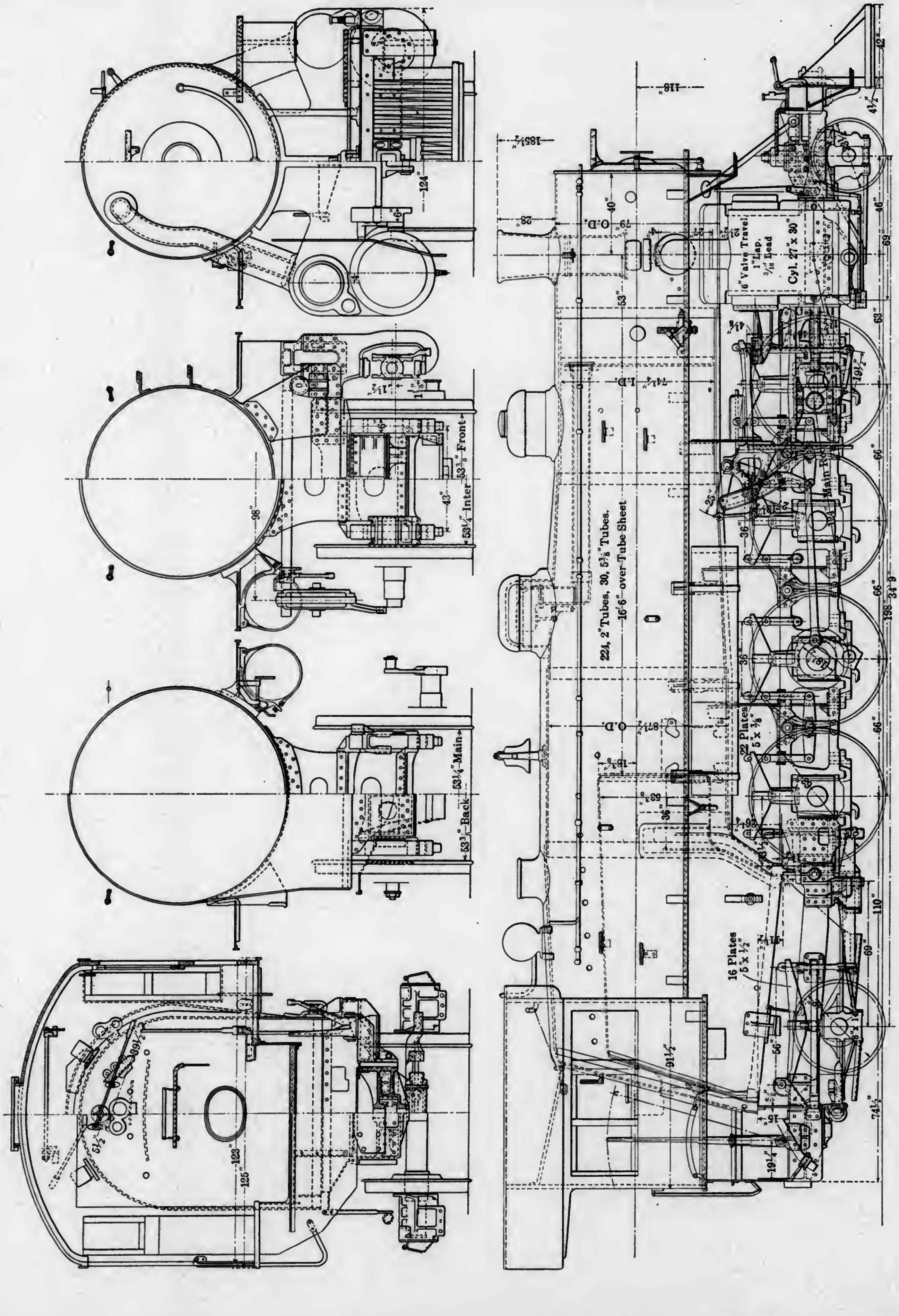
Volatile matter from about 25 to 27 per cent. Fixed carbon, 65½ and 64 per cent. Ash, 9½ and 9 per cent. Moisture determined separately ran over 2½ per cent., and sulphur, 1 to 1.5 per cent. B.T.U's averaged about 13,800.

In the following table are given the average of six trips of the locomotive equipped with superheater, hand fired, both with and without a brick arch:

	With Arch.	Without Arch.	Per Cent. Increase
Average tons back of tender	3,612	3,365	
Average running time, hours	4.32	4.07	
Average speed running m,p,h	13.6	14.4	
Coal consumed per hour with throttle open, lbs	4,021.5	4,633.	
Dry coal fired per hour, lbs	3,924	4,514	15*
Equivalent evaporation per lb. of dry coal	9.65	8.47	14
Equivalent evaporation per hr. per sq. ft. H. S	9.57	9.66	
Boiler horsepower	1,097.1	1,106.8	
Draft in smoke box, front of diaphram	5.4	5.79	
Temperature in smoke box	515.2	517.6	
Temperature of fire box	1,797.	1,711.	
Thermal efficiency of boiler, per cent.	67.66	58.56	15.5
Ton-miles per ton of coal	25,595	21,899	16.8
Dry coal per dynamometer h.p. per hr.	3.07	3.42	10.2*
Thermal efficiency of locomotive	6.02	5.32	13.1

* Decrease.

"Tests of Nickel-Steel Riveted Joints," by Arthur N. Talbot and Herbert F. Moore, has just been issued as Bulletin No. 49 of the Engineering Experiment Station of the University of Illinois. This bulletin describes tests of riveted joints of nickel-steel in tension and in alternated tension and compression. The slip of rivets and the strength of joints were determined. From the tests, the general conclusion is drawn that in riveted joints, designed on the basis of ultimate strength, the use of nickel-steel may be of advantage; but that in riveted joints designed on the basis of frictional hold of rivets, while it may be advantageous to use nickel-steel for the plates, rivets of ordinary steel seem to resist slip as well as rivets of nickel-steel. Copies of Bulletin No. 49 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.



AN EXAMPLE OF THE LATEST IDEAS IN FREIGHT LOCOMOTIVE FOR HIGH SPEED AND AMPLE BOILER POWER.

POWERFUL FREIGHT LOCOMOTIVE WITH SUPERHEATER

MISSOURI PACIFIC RAILWAY.

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These locomotives use superheated steam at 170 lbs. pressure and have cylinders 27 x 30 inches, giving a tractive effort with 63-inch wheels, of 50,000 lbs. The weight on drivers of 209,500 lbs. is about 76 per cent. of the total weight and gives a factor of adhesion of 4.19, which is not far from the average ratio for this class of power.

While there is nothing particularly unusual in this design, it will be noticed that the boiler, while comparatively small, indicating a limit on the total weight allowed, is particularly well designed to take full advantage of the type of locomotive. This feature is noticeable in the depth of the throat sheet, which is 26¼ inches below the barrel and is carried up at an easy angle, tending to assist free circulation into it from around the bottom of the combustion chamber and barrel of the boiler. This gives liberal space above the grates and by the insertion of a 36-inch combustion chamber gives an opportunity for more complete combustion before the gases enter the tubes.

The firebox is made 66 inches in width inside the sheets, giving a side sheet which flares outward somewhat at the front end. The back head, however, is made smaller and the sheets are gradually brought in at the top, the inner firebox sheets narrowing about 9 inches on the center line of the boiler, and the wrapper sheet about the same.

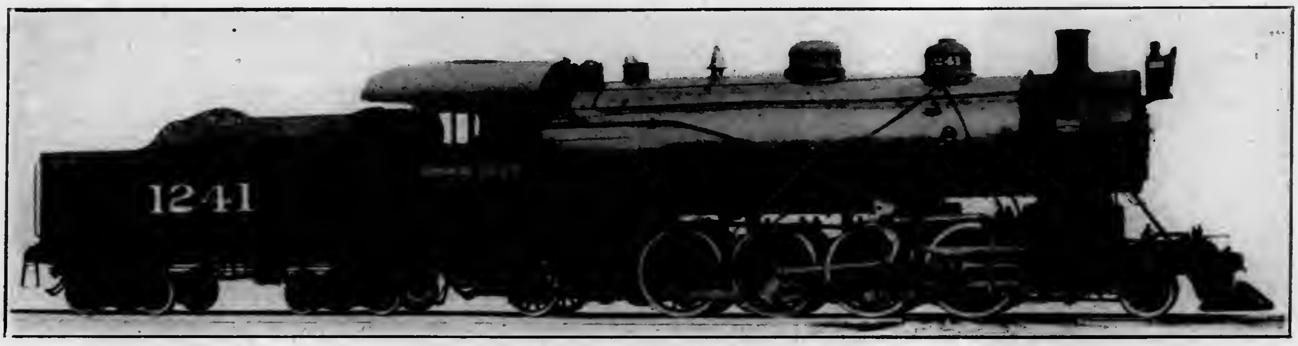
The use of a combustion chamber in connection with the Schmidt high degree superheater reduces the tube heating surface to 2,614 sq. ft., which seems very small for a boiler and locomotive of this size. It has been found, however, that the combustion chamber is more valuable for evaporation than would be equivalent length of flues, and this taken in connection with the economy and capacity given by the superheater, which is at least 50 per cent. more valuable than equal space filled with flues, fully explains this condition, and there is little doubt but what this boiler will be equal to any reasonable demand.

It will be noticed that the customary practice of the builders for steam pipe design has been followed in this case, and also that an extended piston rod, the front end of which carried on enclosed guide, supported by the cylinder head and bumper beam, has been applied. The standard guide for the valvestem crosshead, which is adjustable for wear, has been used, and in all other particulars the locomotive follows the well-established designs of the builders.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	50,000 lbs.
Weight in working order	275,000 lbs.
Weight on drivers	209,500 lbs.
Weight of engine and tender in working order	431,100 lbs.
Wheel base, driving	11 ft. 6 in.
Wheel base, total	34 ft. 9 in.
Wheel base, engine and tender	67 ft.
RATIOS.	
Weight on drivers ÷ tractive effort	4.19
Total weight ÷ tractive effort	5.50
Tractive effort × diam. drivers ÷ heating surface*	848.00
Total heating surface* ÷ grate area	75.00
Firebox heating surface ÷ total heating surface* %	6.85
Weight on drivers ÷ total heating surface*	56.50
Total weight ÷ total heating surface*	74.30
Volume both cylinders, cu. ft	19.86
Total heating surface* ÷ vol. cylinders	186.00
Grate area ÷ vol. cylinders	2.48
CYLINDERS.	
Kind	Simple
Diameter and stroke	27x30 in.
VALVES.	
Kind	Piston
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance	0 in.
Lead	3/16 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11x12 in.
Driving journals, others, diameter and length	10x12 in.
Engine truck wheels, diameter	33½ in.
Engine truck, journals	6½x12 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8x14 in.
BOILER.	
Style	Conical
Working pressure	170 lbs.
Outside diameter of first ring	75¾ in.
Firebox, length and width	108¼x66 in.
Firebox plates, thickness	⅜ & ⅝ in.
Firebox, water space	F. & S.—4½, B—4 in.
Tubes, number and outside diameter	224—2 in.
Tubes, superheater	30—5⅜ in.
Tubes, length	16 ft. 6 in.
Heating surface, tubes	2,614 sq. ft.
Heating surface, firebox	254 sq. ft.
Heating surface, total	2,868 sq. ft.
Superheater heating surface	558 sq. ft.
Grate area	49.5 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	187⅝ in.
TENDER.	
Frame	Cast Steel
Wheels, diameter	33 in.
Journals, diameter and length	5½x10 in.
Water capacity	8,000 gals.
Coal capacity	14 tons

*Equivalent heating surface = 3,705 sq. ft.



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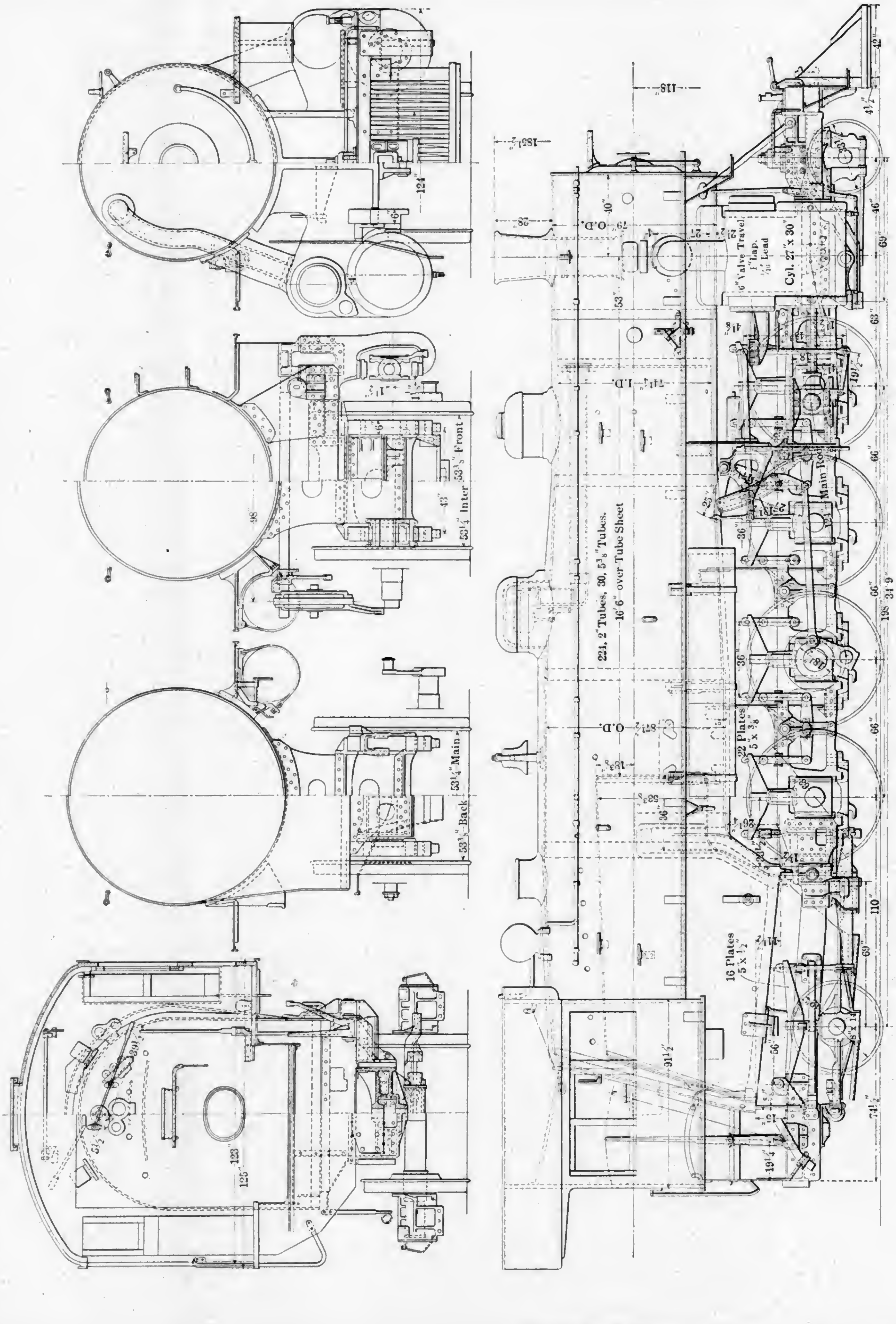

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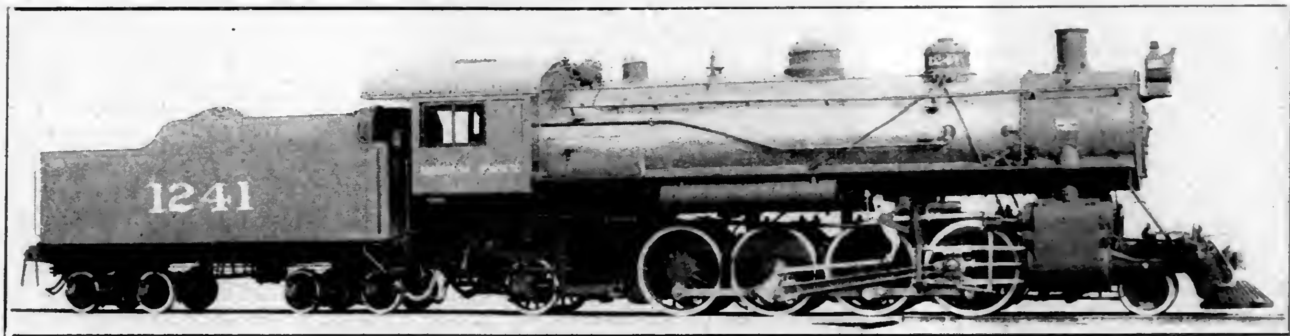

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SHOP FLOORS*

No floor surface is perfect from every point of view. The question of what floor to adopt for a shop is therefore always a choice between different combinations of good and less good qualities. While the factor of cost is apt to be considered the dominating one there are many situations in which cheapness is not the most important item in the choice of a floor; or to put the matter a little differently, it is sometimes economy to discard the floor that is cheapest in first cost for a different floor of higher cost which will justify this higher cost because of its better adaptation to the particular kind of service required of it. Therefore, although I have been asked to speak particularly about granolithic floor surfaces for shops, I am not in the attitude of advising granolithic floor for any and every service under any and all conditions. The granolithic surface has good qualities of great importance and I shall give these qualities due weight. But I shall also point out some of the circumstances under which it may be better in particular cases to put in wood floors.

In first cost the granolithic floor surface has the advantage over a wood floor, the cost of such a surface laid in the best manner being about equal to the cost of seven-eighths maple flooring delivered at the work. Besides this advantage in cost, the granolithic surface is fire-proof and waterproof, and will not decay or disintegrate under washing with water, which is one of the weak points of the wood floor.

There are other considerations involved in a decision between granolithic and wood floors concerning which it is unsafe to be very dogmatic without first defining very precisely the conditions of each particular case. Taking first such a matter as the wear of these two types of floor, it is easy to see that a wood floor is more easily repaired than a granolithic surface, and that repairs to a wood floor can bring the floor to its original maximum efficiency. A granolithic surface also can be repaired so that the new patches will be quite as good as the original surface, but the time and care required is much greater than with a wood floor. In repairing a granolithic surface it is necessary for best results to cut out the broken or defective portion down to the slab, leaving the cut with vertical edges. Next, the slab must be cut with a sand blast or acid until the aggregate stands out sufficiently to give a good bond for the new surface. Then the slab, and edges of the cut, having first been well wetted, must be grouted with neat cement mortar, on which the new finish is laid before the grout has set. Finally, the patch must be kept wet, and protected from use for at least a week. It is rarely possible to satisfy all these necessary conditions, and it is therefore true that under average practical conditions, the repaired portions of granolithic floors are inferior to the original surface in wearing quality.

In this contrast between wood and granolithic floors we have to deal with the question of workmanship. With a maple top floor the difference in wearing quality between a floor laid by a first-class carpenter and the floor laid by a merely average carpenter, is comparatively slight; but with the granolithic finish, ignorant or hasty work is disastrous almost from the outset. The granolithic finish, to give good service, must be laid according to the right theory, and every step in the workmanship must be first class. It is not at all difficult to get a first-class granolithic surface if one starts out with a determination to have it. Good work costs very little more than poor work. It must be admitted, however, that a great many granolithic floors have been unsatisfactory. Poor workmanship and wrongly chosen materials are the reasons.

Among objections which have been raised to the granolithic surface, one of the most prominent is the bad effect of the concrete floor upon the health and comfort of the operatives who stand upon it. There seems to be little doubt that long standing in one position on a concrete floor is not good for the operative. The reason for such ill-effects as occur is not the excessive hardness of the concrete floor, as is so generally supposed, but its great heat absorbing power. Wood is a poor conductor, a poor radiator, and therefore in general a pretty effective insulator. But when an operator stands for hours on a concrete floor the heat of his body is conducted from his boot soles into the concrete rather rapidly. In consequence of this drawing away of the body heat, feet and legs become more or less chilled, the circulation in the legs is slackened, and pressure on the skin of the feet, coupled with this sluggishness of circulation, due to the loss of heat, may easily give rise to sore feet and to various pains which are commonly classed under the head of "rheumatism."

That these bad effects do occur has conclusively appeared in investigation of the whole question made by the Aberthaw Construction Company about a year ago. For operators who are moving about while at their work, or who wear thick-soled boots, this excessive extraction of the body heat by the concrete floor is a negligible matter. For men working steadily at the machines in one position, some insulation is required. It is the practice in many machine shops to give the men foot boards or gratings of wood on which to stand. These do away altogether with any ill-effects from the concrete floor.

Granolithic floors have been attacked as not sufficiently durable under the rough usage of machine shops and foundries. Here again we have to take into consideration the all important items of materials, workmanship, and theory of construction. Nothing but the hardest natural stone in the way of a masonry floor can long withstand the wear of heavy trucking. The usual form of truck is provided with small diameter wheels having a flat tread and sharp edges, and such wheels with the tilting or slewing of trucks that is always in evidence in turning corners, will gouge and dig into any kind of floor. But the granolithic finish can be so made with such a high percentage of tough, elastic aggregate that the wear of trucking is borne almost exclusively by the aggregate itself. Nothing but steel and granite can outwear such a floor. It is the part of wisdom in laying granolithic floors over which there is a heavy truck traffic along certain lines, to provide steel plates or gratings properly set in the concrete to form lanes or tracks for the heavy trucks.

The nature of the tools, processes and products in a given shop bear on the decision between granolithic and wood floors. An edged tool dropped edge down on a granolithic floor would be damaged by the impact, while the same tool dropped edge down on a wood floor would dig into the wood and probably suffer no damage. Also, a manufactured products consisting of delicate metal pieces would be much more damaged by falling on a cement floor than on a wood floor. Still further, the dust produced by the wear of some granolithic surfaces has proved harmful to delicate machinery in some shops. The wood floor does not of itself produce a dust capable of any visible action as an abrasive. It is possible, however, by glueing battleship linoleum to a concrete floor to get many of the advantages of a wood surface. Tools and small manufactured articles are as little likely to break by falling on a linoleum surface as upon wood. The linoleum is without the innumerable cracks of the wood floor and therefore is much more easily kept perfectly free from dust. Linoleum is also an efficient insulation against loss of body heat to the concrete floor.

High resistance to wear of every sort and practically complete dustlessness, that is to say, freedom from the production of abrasive dust, can be secured in a granolithic surface properly made. It is always better that a granolithic finish should be laid on the floor slab while the latter is still green. A better bond between the finish and the slab can be obtained in this way than is possible after the slab has fully set. Unfortunately, the conditions governing the erection of concrete buildings usually put off the laying of the floor finish until all the rest of the building is practically completed, and this involves the need of using great care in cleaning and roughening the slab surface so that the granolithic finish laid upon it will get the best possible bond with the slab. Ordinarily the finish need not be more than three-quarters of an inch thick. Both for wearing capacity and for the avoidance of dust through abrasion of the concrete, the granolithic finish should contain the highest possible proportion of tough stone aggregate.

* Discussion by Leonard C. Wason on paper entitled "Factory Construction and Arrangement," before Am. Soc. M. E.

For the most durable and most nearly dustless floor my rule is this: First, it is better to use no sand; sand grains are brittle, are early broken by the abrasion of feet, and cause dustiness. Use for an aggregate a stone suitable for macadam road, taking the sizes that pass through a half-inch round mesh screen, and nothing smaller than that passed by a 20 mesh screen. Mix the concrete dry of the consistency used in making blocks, so that considerable tamping will be required to bring to the surface enough water for trowelling. Finally, do the trowelling before the mortar sets. It is practicable in this way to get a surface that is 90 per cent. hard stone; the mortar, of course, wears more quickly, but its small area makes the results of this wear unobjectionable. Prolonged trowelling of a wet mixture brings to the top the "laitance" of the concrete, which is the part incapable of a true set. A top layer of laitance is therefore porous and wears down quickly. Even the fine particles of good cement should not be brought to the top, for they form a layer which is weakly bonded to the rest of the concrete, and which wears away quickly, appearing in the air as dust.

A PRACTICAL DEMONSTRATION IN FUEL ECONOMY

LEHIGH VALLEY RAILROAD

The impetus given the general question of fuel economy has without a doubt been one of the most prominent features of railroad operation during the past two years. Some of the savings effected have been remarkable in many ways and principally because they were secured through the co-operation of the engine crews and not through any particular improvement in existing conditions or in the quality of the fuel used.

The amount of money expended yearly for locomotive fuel is the largest single item of expense, excepting labor, that has to be met by railroads. Its magnitude is indicated by statistics furnished by the Lehigh Valley Railroad, which show that the fuel consumed by its locomotives for the year ending June 30, 1910, cost about $3,000,000. During this period there were in the service approximately one thousand firemen, which indicates that the cost of fuel handled by each fireman averaged $3,000.

The railroads generally realize that the fuel problem is largely in the hands of the engineers and firemen, and results have been chiefly achieved through direct appeal to the engine crews; intelligent direction of their efforts without arbitrary dictation, and the presentation of compelling and easily understood arguments to show just how potent the effect of a little extra care and watchfulness implies to the coal pile. For instance, the Lehigh Valley points out that if each engineer and fireman would reduce the cost of fuel one cent per locomotive mile, which would mean about two less shovelsful of coal per mile, it would amount to a reduction in cost of fuel of over $200,000 a year; or, in other words, a saving of $200,000 annually can be effected by engine crews making this apparently insignificant improvement. The saving cannot, of course, be made by one man alone, but it requires the united efforts of the one thousand firemen employed by the Lehigh Valley, and an equal number of engineers.

In order to emphasize what can be accomplished through this effort this road recently undertook the most remarkable practical demonstrations of which there is any record, and this was no less an achievement than that of running one engine through without charge on a heavy passenger train between Buffalo and Jersey City, a distance of 446.6 miles.

That the argument might be stronger and more appealing to the Lehigh Valley men, it was decided to use a locomotive which was a product of the road's own shop, and one of the class "F-6," No. 2475, was accordingly selected for the test. This is one of the 4-4-2 type which were designed in the office of the mechanical engineer, and remodeled in the Sayre shop, being placed in service in November, 1910. Although the railroad company calls these rebuilt engines, they are to all intents and purposes new, as only a few old castings were used in their reconstruction. These locomotives were not only well designed, but carefully constructed as well, which is evinced by the low maintenance cost since being placed in service. Their general appearance indicates that every man who worked on them felt the keen personal pride in his work which calls forth the best effort.

In view of this noteworthy run, which will no doubt remain as the record of individual locomotive performance for a long time, the principal dimensions of these class F-6 engines will be of interest:

Class	F-6.
Type	Atlantic.
Cylinders	21" x 26".
Diameter drivers (over tires)	77".
Boiler pressure	200 lbs.
Tractive effort	25,310 lbs.
Total weight of engine and tender	303,100 lbs.
Weight on drivers	99,700 lbs.
Fuel	Bituminous coal.
Firebox	Semi-wide.
Flues	374, 16' 2" long.
Grate area	51.2 sq. ft.
Heating surface, flues	3,164 sq. ft.
Heating surface, firebox	160 sq. ft.
Heating surface, total	3,324 sq. ft.

On June 21, 1911, locomotive No. 2475, with engineer John Corey, and fireman Frank Pettit in charge, left Buffalo on train No. 4, consisting of ten cars, and started on the run of 446.6 miles to Jersey City. This crew was in charge of the locomotive the entire distance without taking coal, or cleaning the fire. Between Wilkes-Barre and Fairview, a distance of 16.3 miles, with a grade of 95 feet to the mile, a helping engine assisted the train, which is the usual practice. The regular locomotive crews east of Sayre acted as pilots, engineer Corey and fireman Pettit not being familiar with that part of the road.

The following table gives the weight of the train and the distance each weight was hauled:

Stations.	Miles Run.	Cars Hauled.	Tons behind Tender.	Car Miles.	Ton Miles.
Buffalo to Bethlehem...	359	10	560	3,590	201,040
Bethlehem to Easton....	11.6	8	433	92.8	5,022.8
Easton to Jersey City...	76	7	372.8	532	28,332.8
Total	446.6			4,214.8	234,395.5

The summary of the run is given below:

Date	June 21, 1911.
Engine	2475.
Weather	Clear.
Temperature	80 degrees (average).
Rail	Good.
Wind	Light.
Coal	Bituminous.
Number of stops made	31.
Number of miles run	446.6
Number of cars hauled	10-8-7.
Total car miles	4,214.8.
Total ton miles	234,395.6.
Time leaving Buffalo	9. 58 A. M.
Time arriving Jersey City	10.01 P. M.
Time on road	12 hrs. 3 min.
Time scheduled	11 hrs. 57 min.
Time actual running	10 hrs. 40 min.
Number of times fire cleaned	None.
Times fire was raked	None.
Times grate shaken	6 (slightly).
Coal leaving Buffalo	34,050 lbs.
Coal arriving Jersey City	3,980 lbs.
Coal consumed	30,070 lbs.
Coal per train (or locomotive) mile	67.33 lbs.
Coal per car mile	7.134 lbs.
Coal per ton mile	0.128 lbs.
Coal per square foot grate area per hour	48.94 lbs.
Average steam pressure	195 lbs.
Minimum steam pressure	190 lbs.
Times water was taken	8.
Average speed, deducting stops	41.8 miles per hour.

The following table gives a comparison of some of the figures taken from this test run and corresponding figures for the year ending June 30, 1910:

	Coal per Pass. train mile.	Coal per Pass. car mile.	Shovels full per mile @ 14 lbs.
Train 4, June 21, 1911...	67.33 lbs.	7.134 lbs.	4.8
Average 1910...........	132.2 lbs.	24.4 lbs.	9.4

From the above it can be appreciated what is possible by careful manipulation of a locomotive by its engineer and fireman. This performance in all probability is the most remarkable ever made in this country by an engine hauling a heavy train on schedule time. The total amount of coal used between Buffalo and Jersey City was 15 tons and 70 lbs., while the amount of coal consumed usually on this run is between 25 and 30 tons. When the distance run, train hauled, coal consumed, which was less than five shovelsful per mile, the time made up and the average steam pressure are considered, the performance reflects great credit on all who were instrumental in making it a success.

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REDUCTION OF RED TAPE

An incidental benefit of the unit system, as now practiced on the Union Pacific and Southern Pacific railroads, appears to be a large reduction in correspondence, and practically the elimination of red tape. It is estimated, although the exact figures are not obtainable, that within the last two and one-half years the application of the principles of the unit system has caused a reduction of more than 500,000 letters a year in the correspondence of the operating department of the Harriman lines. Where previously at the same headquarters it was said that several partial records of a transaction existed, now there is one complete record.

The unit system of organization has now been installed in the general operating offices and on twenty-two operating divisions of the Union Pacific system, and the Southern Pacific system, of the Harriman lines. Some of the underlying principles of the system have been applied to several other offices and divisions of these lines. The unit system it may be said, like all other similar innovations, depends for its success upon the spirit of co-operation existing and engendered in the persons responsible for its every-day working.

THE BRICK ARCH

Users of the brick arch five to ten years ago can be divided into two classes, those who found sufficient advantages in it to more than equal the expense of the brick and trouble of maintaining them, and those who found their conditions such as to make the arch unprofitable. Both classes have much to learn concerning the brick arch as it is now being designed. The sectional arch now being generally applied is much different from the old-style design and eliminates all of the principal objections previously raised, permitting the advantages to be obtained under nearly all conditions without the offsetting disadvantages and unwarranted expense.

Carefully conducted tests on all sides indicate the arch to be one of the most valuable fuel economizers or capacity increasers. As reported in another part of this issue, the tests on the New York Central Mallets show that in connection with the superheater, the arch alone gave a fuel saving of about 11 per cent. As we begin to approach the limit of the fireman's endurance an opportunity for an 11 per cent. saving in fuel, or, in other words, a 13 or 14 per cent. increase in capacity of locomotive is of inestimable value.

It is interesting to investigate the effect of the arch in the firebox which causes such a difference in the boiler capacity as a whole. The arch as now generally installed is carried on water tubes, from two to four in number, depending upon the width of firebox, extending from the inside throat sheet to the upper part of the back firebox sheet. The arch brick in small sections, each of them of a size to be conveniently handled by one man, rest on and between these tubes and are carried upward to a point about 18 to 24 inches from the crown sheet, extending back from ½ to ⅔ of the length of the firebox. They are sometimes tight against the throat sheet, but more often a space of 3 or 4 inches is left open at this point.

In a firebox without a brick arch, when the door is closed, the flame and gases from the fuel bed probably take an almost direct path to the tubes, in which case the back firebox sheet or door sheet, a large part of the crown sheet and the upper back corners of the side sheet have no direct impinging action from the flame and receive only radiated heat. While no one yet has accurately determined what the relative value of firebox and tube heating surface may be, there is do doubt but what firebox heating surface is several times as valuable as an equal amount in tubes, and in a locomotive without a brick arch fully half of this surface is not utilized to the best advantage.

When the arch is installed, the flames are compelled to pass backward underneath it and then make a sharp turn over the top of the arch, in this way impinging directly against the door

sheet, the crown sheet and the back part of the side sheets, permitting them to transmit as much heat as the water circulation back of them will absorb. At the same time, the section in front and above the arch are not robbed of their opportunity.

There is another feature in connection with the brick arch which seems to explain part of the result, and that is in getting and holding very high temperatures along the bottom of the side sheets. The amount of heat passing through a steel plate is to some extent governed by the same rules as the amount of water passing through a pipe, *i. e.*, the difference in temperature between the two sides of the sheet act much the same as the difference in pressure at the two ends of a pipe. With the arch the high temperature held along the bottom of the side sheet where there is the lowest temperature on the opposit side gives an opportunity for this surface to transmit its maximum capacity.

While a fair proportion of the value of the arch is probably due to the presence of an incandescent body in the midst of the firebox and the increasing of the length of the flame, it would appear from the discussion just given, that its action simply as a baffle plate is one of its most important features.

BLOCKING THE INITIATIVE

A prominent feature of railroading as viewed in this country of late is the widespread policy of encouraging the rank and file to take the initiative, possibly not so much in action, but in suggestion. It is not at all uncommon to see boxes placed close to master mechanics' offices where the men are requested to deposit any idea, plan of work or appliance which may be in the direction of improving existing conditions or methods. In consequence of this obviously correct procedure, thousands of ideas have been worked into practical possibilities of incalculable value to the general scheme of locomotive maintenance.

It is rather expected, indeed, from an American standpoint, that mechanics shall be originators of ideas, and it is quite evident that of late they have measured up to it. In fact, it may be said that many of the advanced ideas which prevail to-day originated at the bench or the machine, and railway management sensibly fosters this inventiveness.

In contrasting shop methods abroad with those prevailing in this country it is impossible not to be impressed by the fact that very little initiative seems to be permitted or taken advantage of by either shopmen or their foremen. This is particularly noticeable in the lack of the commonest labor-saving devices, and what have been termed on this side of late "shop kinks," are practically unknown quantities. An observer will search in vain for the examples of inventive ingenuity which practically every American shop can afford in profusion, and which in many instances have so greatly simplified and cheapened production as to be unbelievable.

A very interesting study is afforded in this contrast and it will be found as it progresses that the problem is not by any means unsolvable. In the long run it simply resolves to the fact that in this country the workman is given every encouragement to think, from the time when he enters on his trade as apprentice until the highest pinnacle has been reached, while abroad he is encouraged not to think, the latter being largely the perquisite of the directing heads.

This impression was formed after a very long and close analysis of foreign shopmen and methods, and even of the train service. Every move is laid out in advance, so far as any possible contingency can be estimated, both in the shop and on the road, and this detail is indeed carried to such a refinement that it would appear the man who does the thinking would not only consider any omission a very serious matter, but a personal reflection as well.

In keeping with this condition it is not surprising that the men in the large repair shops appear to be a very comfortable lot. They take life easily and impress the visitor as not intending to work too hard. Certainly they do not appear as a body who would remain up nights endeavoring to evolve new jigs and methods. Should they attempt the latter it is not at all likely that the suggestion would be viewed with any particular favor, even if they could be placed before the head, who, by the way, is very much further removed from his rank and file than any superintendent of motive power under our plan of organization.

So long as this heavy thinking is done by very few men they are enormously compensated. F. M. Webb, chief mechanical engineer of the London and North Western Ry. of England, received the equivalent of $35,000 per year. They are willing to pay a man well who can think for his entire department. It is said that Mr. Webb discouraged his men to produce labor-saving devices because he had an ample staff of mechanical engineers for that purpose and who were well paid to do all of the inventing. Thus the range for originality became somewhat constructed on that system at least.

It is practically unknown for a subordinate official, even, not to mention the vast rank and file, to take the initiative. The features of personality and individuality which endow American railroading with such a valuable as well as picturesque aspect are entirely lacking abroad, because the employees, through the absolutely inflexible system of organization which prevails, must be largely automatons. The general scheme is also a wonderful example of absolute subordination, one so complete that individual effort is seriously hindered, if not altogether checked. The men are inherently not self-assertive, as in this country, and in the face of the prevailing systems this cannot well be engendered.

RAILROAD SHOP TOOLS

It is a singuar fact in connection with American railway methods that the majority of roads do not seemingly favor the existence of a depreciation fund for taking care of shop machinery, and so far as regards this particular item, at least, something of value might be learned from an analysis of methods in vogue overseas, and especially in England. The system there adhered to makes admirable provision for the maintenance of not only rolling stock, but machine tools as well by setting aside annually a definite amount to be spent for this work. This amount is increased from time to time with the increase in the amount and capacity of the equipment, and it forms an adequate depreciation fund for keeping the rolling stock and shop equipment up to a uniform condition of efficiency.

Five per cent. is taken as a fair amount to be allowed for depreciation on each machine tool per year, and it is claimed that an annual appropriation of 5 per cent. of the value of the machinery in each shop would practically renew the machine equipment once in every 20 years. This must naturally appeal as a far more sensible and consistent procedure than that generaly prevailing where a master mechanic must make a desperate fight for many months before a machine admittedly obsolete can be replaced by one of modern design capable of returning adequate service for the investment.

In this general connection many timely inferences may be drawn of much significance. For instance, in buying new machines care should be taken to select those which will effect the largest earnings. Needless to add that care should also be exercised to see that the machines which are known to be the least profitable should be first replaced by those of modern design. Special machines, excepting wheel and axle lathes, which are as a rule essential, are generally unprofitable except in cases where they can be kept in constant use.

The selection of lathes, for example, is a matter requiring care and deliberation. In many cases it would be preferable to decide on a turret lathe instead of an engine lathe, as on certain classes of work a modern turret lathe will produce from two to five times as much work as an ordinary engine lathe. Another machine which is superior in many instances to the latter is the vertical boring and turret mill or lathe. This machine will produce at least double the amount of work that is possible on an engine lathe; almost anything that an ordinary lathe can do, and

much that it cannot perform, is handled hereon usually in a much shorter time, and in a more satisfactory manner, with the additional advantage of occupying less floor space.

A well-equipped tool room has more to do with the efficiency of a shop than the majority of master mechanics seem to realize. Every tool should have its place and should be kept in good condition for immediate use so that when it is needed it can be procured quickly. Old machine tools should be replaced by modern tools as quickly as possible, for until they are the railroad shop will not be in proper position to reap the full benefits to be derived from high speed steels and up-to-date methods.

QUICK RETURN CRANK SHAPER MOTION

To the Editor:

We refer to your article on page 416, October, 1911, issue, about the quick-return motion of the crank shaper. We use the simple form of quick-return mechanism, and we ask for space to show why we believe this is the best, mainly because it is simple, and why the mechanism described as the two-piece crank is objectional from reverse reasoning, because it is very complicated. We merely wish to show the mechanism of both types so that the railroad mechanical departments can judge between them.

In Fig. 1 herewith is shown the construction of our simple quick-return mechanism. It will be noted that there is but one bearing surface to this bull gear, as compared to ten bearing surfaces in the complicated quick-return mechanism. A little further along we will show these ten bearing surfaces. The one bearing surface of the simple quick-return mechanism is the hub of the bull gear in the column. Be sure to note that this journal is hardened and ground, and has a self oiling bearing. This hardened and ground journal with flooded lubrication will not wear elliptical. It will also be noted that the gear teeth are radial from a point within the bearing to reduce the overhang all that is possible, and that the hub is very long to offset the overhang.

In Fig. 2 we show the four parts of the so called two-piece-crank, obtained by separating the component parts of this bull gear. The ten bearing surfaces, all of which are in action while the tool is cutting, are as follows: Number 1 runs in column and corresponds to the one hub bearing of the simple quick-return mechanism; but although this bearing must take the full thrust of the cut it is very short as compared to the same bearing in the simple quick-return. The other bearing surfaces are numbered so that the journal and its bearing can be easily seen, the journals being indicated by numbers 2, 3, 4, etc., and the corresponding bearing by numbers 2′, 3′, 4′, etc. Number ten is in contact with a flange on the column.

Is it necessary to point out that these nine extra bearing surfaces are increasing friction and wear? It should also be noted that two of these bearings are flat rubbing surfaces (No. 7 and No. 8) acting like a brake, and some of the radial moving parts are placed close to the periphery of the bull gear (No. 4, No. 9 and No. 10) which is more objectionable from a standpoint of frictional increase than a well designed hub bearing. We wish to say right here, that the designing of machine tools is going rapidly away from the complicated to the simple forms of mechanism, and the designer who can get the same action with fewer parts is the most successful.

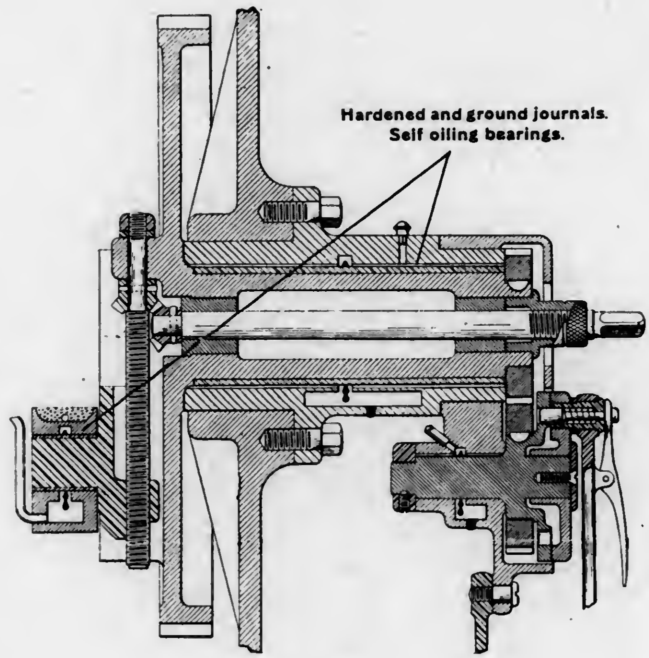


FIG. 1.

We freely admit that the complicated quick-return mechanism shown does bring about the effect desired by its designer, that of a very quick-return and an even cutting speed, but at what a loss of simplicity and power! Power of efficiency is our pet hobby, and we court investigation and tests to demonstrate our position in this respect. Is an even cutting speed so desirable in planing? If so, why is Mr. Powell so enthusiastic over his accelerating cut planer? Further, it has been shown time and again, that the quick-return in planing is not nearly so important as the speed at which the cut can be taken. If the quick-return is so important, why the variable speed planer with a constant return? The accelerating motion of a shaper ram is especially valuable in that it reduces the shock of the tool's entering and leaving the work. A heavier cut can be taken, and a faster speed maintained. In other words, more work and better work with less expenditure of power.

Queen City Machine Tool Co.,
Cincinnati, O.

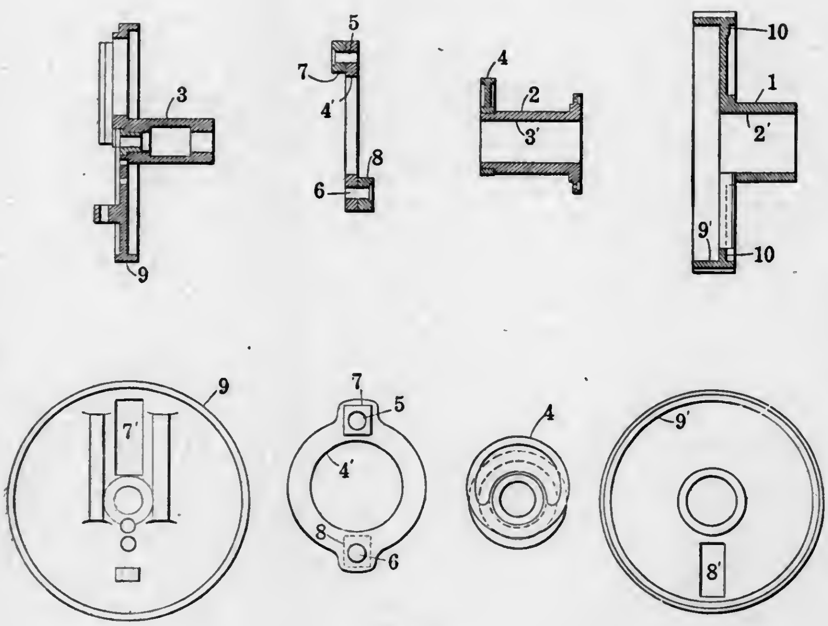
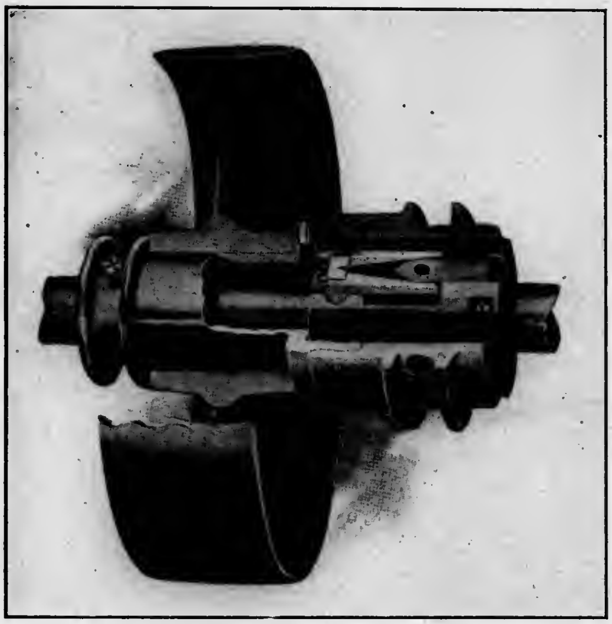


FIG. 2.

IMPROVEMENTS IN SPEED CLUTCHES

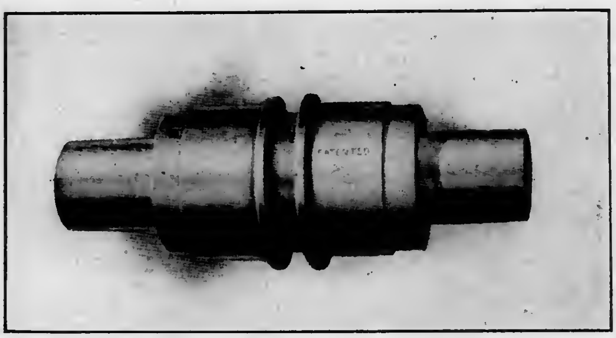
The advent of high speed steels, demanding better and more powerful clutches on countershafts, and many other requirements imposed by modern practice, has resulted in a very high development of these devices. They have been adopted for use as parts of machines by some of the leading manufacturers with perfect success. For the past several years the Carlyle Johnson Machine Co., of Manchester, Conn., makers of the Johnson friction clutch, have been embodying many improvements which simplify the working mechanism of these clutches, and add to their efficiency, with the result that a product is attained in the new design leaving practically nothing to be desired from the viewpoint of either efficiency or simplicity.

As will be seen in the accompanying illustrations, this clutch has but few parts, and is very compact. A body fastened to the shaft carries a split ring in which are inserted a pair of levers. A curve-shaped wedge, which is made part of a shipper sleeve, forces the levers apart, expands the ring and brings the outer surface into frictional contact with the inner surface of the friction cup, the hub of the latter being made to suit requirements.

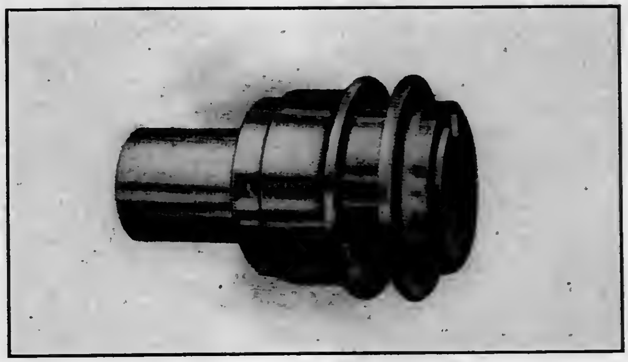


SECTION SHOWING CLUTCH ENGAGED AND PULLEY MOUNTED ON HUB OF FRICTION CUP.

The leverage is so compounded that very little pressure is required to operate the clutch. One screw which moves two taper blocks, set into the levers, adjusts the contact of the ring and cup to any tension. This is easily reached with a screw driver through a hole in the friction cup. The perfectly smooth shipper sleeve entirely covers the working parts so no dirt can get near them. The double clutch requires but little more space than single and has two friction cups with hubs on which can be mounted pulleys, cones, gears, etc., of any diameter and face.

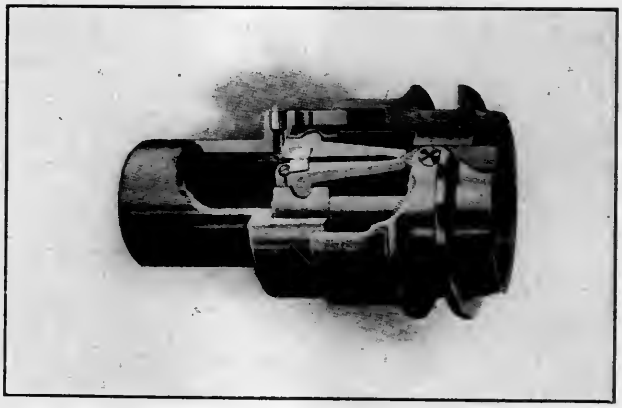


DOUBLE CLUTCH—EXTERIOR.



SINGLE CLUTCH—EXTERIOR.

The double clutch has been employed with great success in the instance of some of the largest machine tools ever constructed, a notable illustration being in connection with the Betts' heavy boring and turning mill. One of these machines swings 20 ft. 3 in. in diameter and takes work 12 ft. high under the tools. The tool spindles have a travel of 72 inches, and the total weight of the machine is 373,000 lbs. In this very massive design ease of operation has been very largely secured through liberal use of the friction clutches above described. Two double clutches are used in the nest of gears on either side of the machine, the design being such that the face plate or table, instead of being driven by one pinion, is driven by two pinions, one on each side. The feature of driving from both sides of the table tends toward smooth running and increased stiffness under cuts that are not entirely continuous. The Newton 30 in. horizontal milling machine and the Newton I-beam, cold saw cutting off machine afford additional instances of how this small compact clutch is used by machine tool builders as part of some of the best high grade machine tools built. It is said that 16,000 of these clutches have been used by one manufacturer of turret lathes as part of the lathe head.

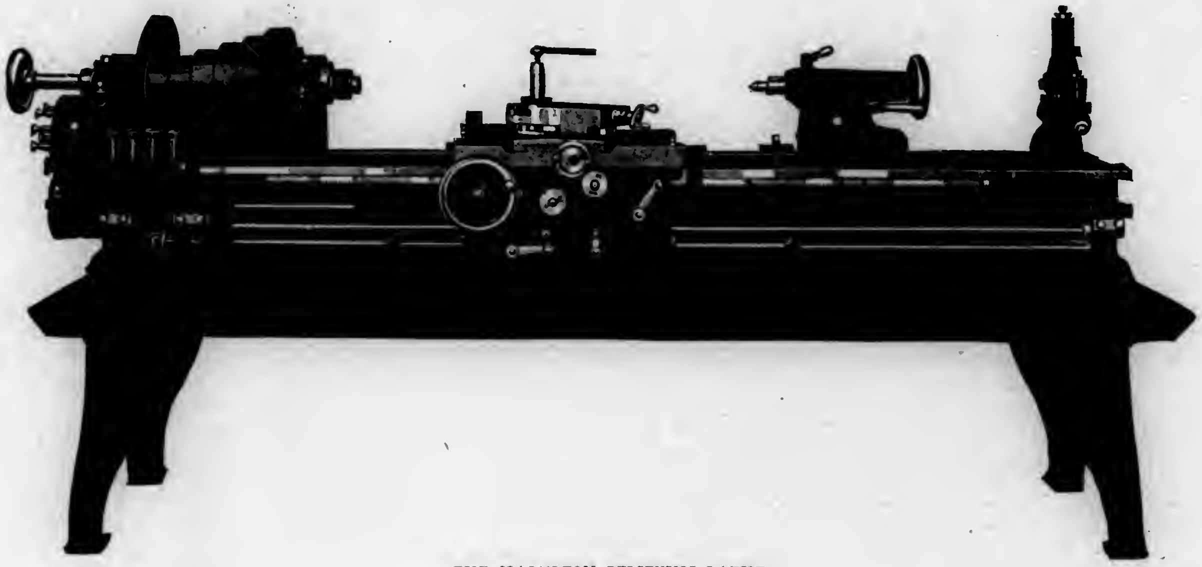


SECTION SHOWING CLUTCH DISENGAGED.

The method of driving machinery direct from the line shaft by the employment of this device, without the use of countershafts over each machine, is also of decided interest. The saving in power, pulleys, countershafts, overhead or across belts, the maintenance of which is a constant item of expense and amounts to considerable each year, soon pays for this equipment. This form of direct drive is now being extensively used by many large manufacturing concerns throughout the country with entire satisfaction. The amount of friction eliminated and the power saved by such a drive can no doubt be readily appreciated.

A REMARKABLE NEW RELIEVING LATHE

One of the most progressive steps in lathe manufacture that has occurred in many years is noted in the new "Hamilton" relieving lathe, which is the latest production of the Hamilton Machine Tool Co., of Hamilton, O. This new machine is a lathe with a relieving device for backing off straight or taper taps or reamers, also for both straight, angular and face mills. The novelty of this construction is that it will not only do the work of any lathe, but will do the work of any relieving machine as well.



THE HAMILTON RELIEVING LATHE.

The attempt has been made in the past to provide this dual capacity through relieving attachments, but these cannot be likened to other than makeshifts, as through their use only straight work is possible, whereas in the machine under consideration taper, angular and face work can be performed with equal facility. This relieving device is not an attachment in any sense, but is built into and is a part of the lathe itself. At the same time the interchange of a long screw for a short one throws out the relieving feature of the machine and converts it into a standard lathe. The new machine will relieve all straight and taper tap and reamers, also all straight and angular face mills up to 10 in. in diameter, with any number of teeth from two to sixteen. It is not confined to outside relieving, but will do inside work as well, such as hollow mills, doing it as rapidly and as accurately as a machine built solely for that purpose.

An analysis of the relieving device becomes naturally the most interesting feature in the study of this fine tool, and through reference to the line drawing of the top of the carriage its operation may be readily grasped.

In this *a* is a coiled spring adjusted by means of a screwdriver screw and is provided with a lock nut, which should be kept tight so as to maintain an even pressure of the cam link *c* against the cam *b*. Of the latter three are furnished, one double, one triple, and one quadruple, which are sufficient for relieving sixteen numbers of teeth, from 2 to 16 inclusive. This cam is easily removed after releasing the tension of spring *a*, and it is held in place by a screw and washer. *c* is the cam link which is held against the cam *b* by means of spring *a*, and must be removed before trying to lift out cam *b*.

The adjusting block, which gives any amount of relief from 1/32 in. to 5/16 in. is marked *d*, and is operated by the adjusting screw *e*. This is a double screw, one inside of the other, and by loosening the outer screw and turning the inner screw, either to the right or left, the amount of relief is increased or diminished as required. *f* is the adjusting gear and is used for setting the work in proper relation to the tool so that the same will "kick back" at the proper time. This is a very handy feature, as by loosening the two bolts the spindle can be turned by hand without changing the position of the cam. *g* is a short screw, and when the lathe is not required for relieving should be removed and the long screw which is furnished put in its place. This substitution converts the machine into a standard lathe.

The new lathe will handle work up to its greatest capacity between centers, the relieving mechanism being driven from the back gearing through change gears and a splined rod which extends the full length of the bed. The shaft drives a spur gear, which in turn drives another spur gear running loose on a slotted disc which is keyed to a bevel gear shaft. Changing the throw to suit any particular work is accomplished by turning a screw on the outside of the swivel. This regulates the position of the adjusting block that slides along the cam link inside of the swivel and connects with the cam. The swivel itself, turning easily on its center post, enables the tool to be brought up to the work from any position desired. The compound rest tool slide is held up against the cam by a heavy adjustable spiral spring, which assures positive action and reduces the possibility of looseness through wear to a minimum. All shafts on the carriage run in hardened and ground bearings and are provided with hardened and ground thrust washers.

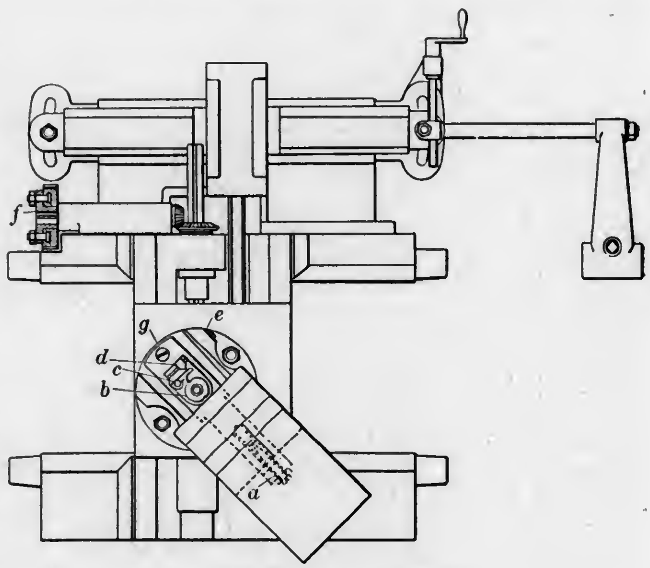


DIAGRAM OF RELIEVING DEVICE.

THOMSEN AND ELNSBR LOCOMOTIVE SUPERHEATER

An occasional objection has been raised in connection with the ordinary form of high degree superheater on the grounds that through the necessary employment of quite a number of large flues to contain the superheater elements there is a very large diminution of the evaporative surface of the boiler. Notwithstanding the fact that this view may be considered as based on theoretical assumption more than on the fact of reduced efficiency an experiment is now under way with the end in view to apply the superheater to tubes of the ordinary diameter. With this end in view Thomsen and Elnser, on the staff of the Schmidt Superheater Co., have been granted patents in Cassel, Germany, on an entirely new arrangement which may be applied without any interference with existing boiler conditions, provided that the flues are of 2¼ in. diameter, or at least above two inches in diameter.

One of the fundamentals in superheater design up to a comparatively recent period was to provide a superheater on each side of the boiler, and to allow each superheater to supply steam to the cylinder on one side of the locomotive only. It has been advanced, in this connection, that this construction makes it often difficult to obtain a sufficient quantity of highly superheated steam for each cylinder. On the other hand, as the steam is only drawn from each superheater twice per revolution of the engine the claim is also advanced that the superheaters are not worked to their full capacity.

In the arrangement herein illustrated, in which interest centers principally is the fact that extra large flues are not a requisite, it will be also noted that provision is made for a superheater with its headers opening into a common duct which supplies steam to the cylinders. These headers or collectors supplying the superheated steam are individually in communication with separate cylinders, the collectors being interconnected in such a manner that all co-operaté in supplying steam to the engine irrespective of the outlet from which it is withdrawn.

Fig. 1 is a longitudinal section through part of a locomotive boiler fitted with the superheater. Fig. 2 is a section on the line 2 of Fig. 1, looking from the right-hand side, and Fig. 3 is a section on the line 3 of Fig. 1, looking from above. The superheaters are arranged with tubes (*A*) situated within the smoke tubes (*B*) of the locomotive. The superheater tubes (*A*) are connected at their ends to headers (*C*) and (*D*), the headers (*C*) being provided with a connection (*E*) to the steam space of the boiler. The superheater tubes (*A*) are disposed as shown, and are connected to their headers by bridge pieces (*F*) bearing upon flanges (*G*) formed on the superheater tubes and secured to the header by means of the bolts (*H*). The headers or collectors (*D*) are connected by pipes (*S*) to the cylinders of the engine, and are also interconnected at their upper ends by the pipe (*J*).

FIG. 2

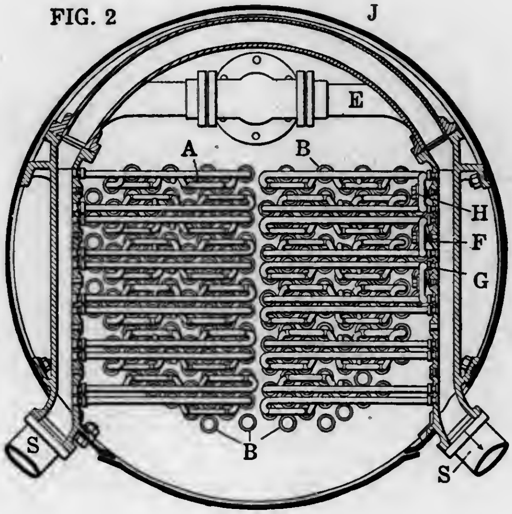


FIG. 1

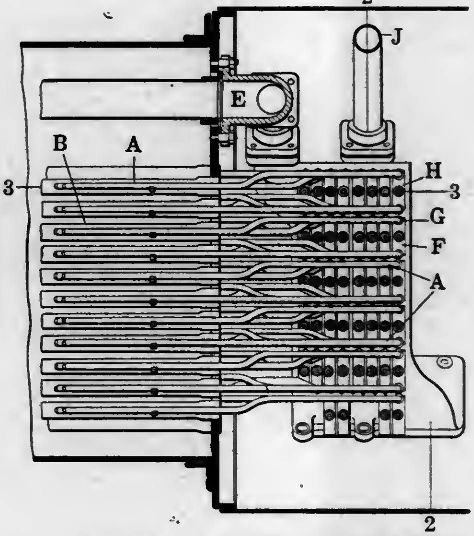
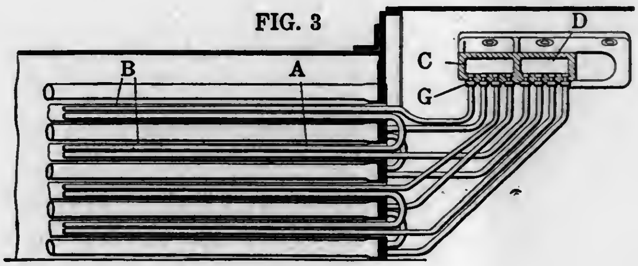


FIG. 3



APPLICATION OF SUPERHEATER TO ALL BOILER TUBES.

By means of this arrangement the claim is advanced that from whichever outlet the steam is withdrawn the whole superheater plant is operative in supplying steam to the outlet, so that an ample supply of superheated steam is provided and the superheaters are worked at their full capacity. The design is not restricted to locomotives, as it may be equally well applied to other plants, in which a plurality of superheaters are used, to supply superheated steam to the cylinders of a multi-cylinder engine.

THERE ARE IN THE WORLD TO-DAY about 1,300 miles of railroads upon which electricity is used for heavy service. Far the greater part of this mileage is in the United States. In addition there are 435 miles of electric elevated and subway lines in the cities of Boston, Chicago, Philadelphia and New York.

WITH THE USE OF PETROLEUM by the transportation and manufacturing industries, California has practically done away with coal as a steam-raising fuel. Oil is also used in that State in making gas employed for cooking, heating and lighting.

ELECTRIC LOCOMOTIVES IN THE HOOSAC TUNNEL

BOSTON & MAINE R. R.

In the newly electrified Hoosac Tunnel, the Boston & Maine Railroad Company has in service five electric locomotives for hauling the trains and their steam locomotives with banked fires through the tunnel. This practically eliminates the obnoxious steam, smoke and gases incidental to steam operation. These locomotives have four geared motors, twelve wheels, and are designed for operation on 11,000 volts alternating current. Two are used for heavy freight service and the remaining three for combination passenger and light freight service.

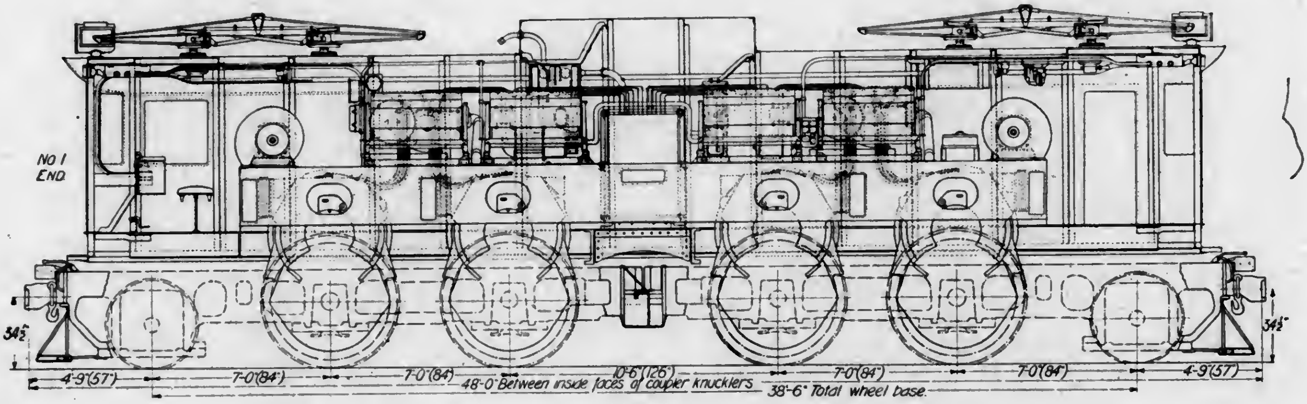
The electrified zone extends from Hoosac Tunnel Station, Mass., to North Adams, Mass., a distance of 7.92 miles, of which 4.75 miles are within the tunnel. The central zone of the tunnel has an almost level track 1,200 feet in length, with an ascending 0.5 per cent. grade up to this level track from both the east and west portals.

For passenger service, the locomotives were designed to handle trains having a maximum weight of 730 tons, inclusive of steam and electric locomotives, and to maintain a schedule time of 14 minutes between East Portal, Mass., and North Adams, Mass. The locomotives for freight service were built to handle heavy freight trains having a maximum weight of 2,000 tons, including both steam and electric locomotives, and are required to accelerate this tonnage on the 0.5 per cent. grade in the tunnel.

These locomotives are similar in every way to those built a little over a year ago for the New York, New Haven & Hartford Railroad, which were illustrated on page 245 of the June, 1910, issue of this journal. They incorporate a running gear consisting of two separate trucks, each having two pairs of 63 inch drivers and a radial pony truck. The motors are mounted on the truck frame over each driving axle and drive through gearing. The truck side frames follow the general design of the cast steel frames for steam locomotives, except that they are outside of the wheels. The side frames are joined at each end by a cast steel box section girder of sufficient strength to care for the stresses involved in bumping in freight service. The bumper girder at each end of the locomotive is equipped with an M. C. B. coupler mounted with a Westinghouse friction draft gear.

ARTICULATED ELECTRIC LOCOMOTIVE WITH CAB REMOVED.

The adjacent bumper girders at the midlength of the locomotive are joined by a drawbar with a pin connection at each end. The eye in this bar is elongated at one end and the length of the bar is so arranged that it is impossible for the bar to be subjected to compression under severe bumping conditions. The three wheels on each side of each truck are equalized together. The longitudinal stability of the trucks is provided by the method of mounting the cab which is supported by eight spring-loaded friction plates, two plates resting on each end of the truck. This relieves the truck center pins of all the weight. This method of supporting the cab interposes two sets of springs in series between the rail and the cab and gives an exceptionally easy riding cab. To relieve the cab from possible pulling and bumping strains, the center pin of one truck is arranged with longitudinal clearance. This truck can not only rotate, but can also move longitudinally relative to the cab.

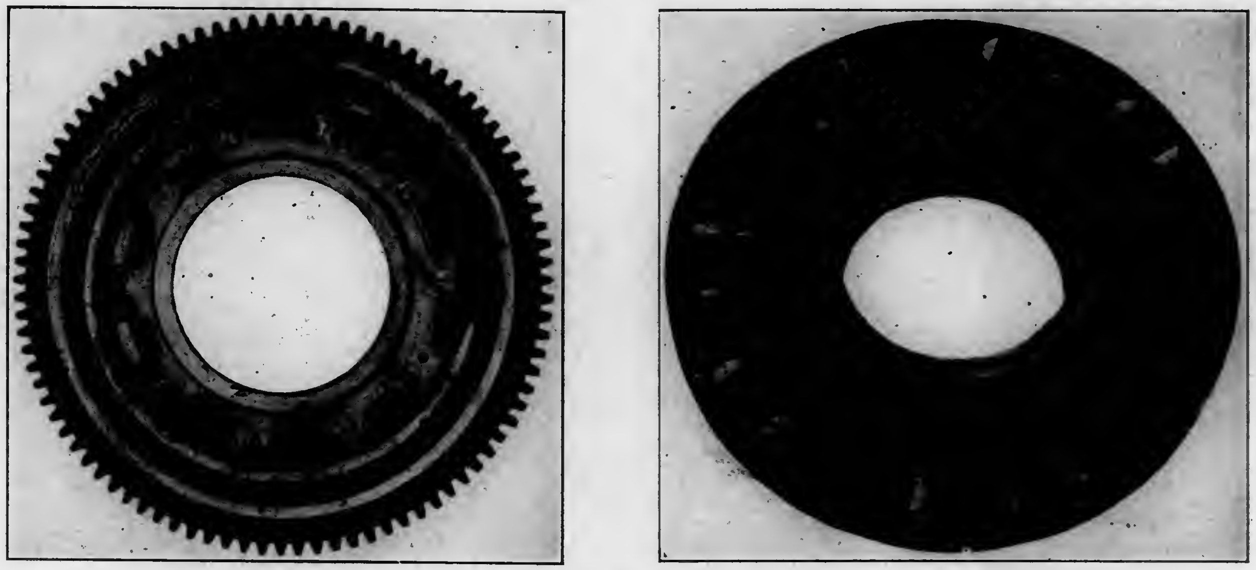


ELEVATION OF B. & M. ELECTRIC LOCOMOTIVE, SHOWING GENERAL ARRANGEMENT.

In the interior of the cab a long raised deck is built along the center line which covers the motors and serves as a stand upon which the control apparatus is erected. The central arrangement of the equipment, with the numerous side windows, affords excellent light and ample room for inspection and overhauling.

Each motor is bolted rigidly to the truck frames and each is so arranged that they can be lifted by a crane after the cab has been removed, or they can be taken out through a driver drop pit. The procedure in such a case requires first the dropping

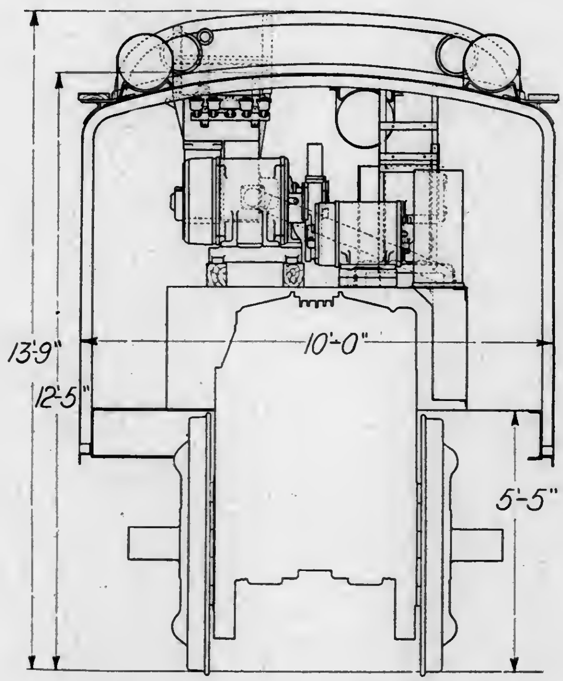
of the drivers with its quill and their removal. The drop pit jack is then placed under the motor and lifts its weight off from the frame. The construction is such that the motor feet rest on the truck frame through bridge blocks, thus after the weight



GEAR RIM AND CENTER, SHOWING FLEXIBLE DRIVE BETWEEN MOTOR PINIONS AND QUILL.

is carried by the jack, these can be removed and the motor dropped directly into the pit.

This method of mounting the motors gives the highest center of gravity possible with the motor connected to the axle by a single reduction gearing.



END ELEVATION OF LOCOMOTIVE.

Like the New Haven locomotives mentioned above, the motors drive through a flexible connection to the drivers, the arrangement being as follows: Around each driving axle there is a hollow axle or quill which carries at either end a large circular casting having six arms projecting out between specially designed spokes of the wheel centers. Each of these arms is bolted to one end of a large helical spring, the other end of which is secured to the wheel center. This circular casting also acts as a center for the large gear rim which is secured to it in such a manner that the drive on the rim which comes directly from the pinions mounted on either end of the armature shaft is transmitted through ten small helical springs. In addition to giving a flexible drive this construction also permits each wheel complete individual freedom in negotiating track inequalities. The weight of the quill and its attached parts is carried in large bearings, forming part of the motor frame, having removable caps below to permit the convenient dropping of the quill with the drivers.

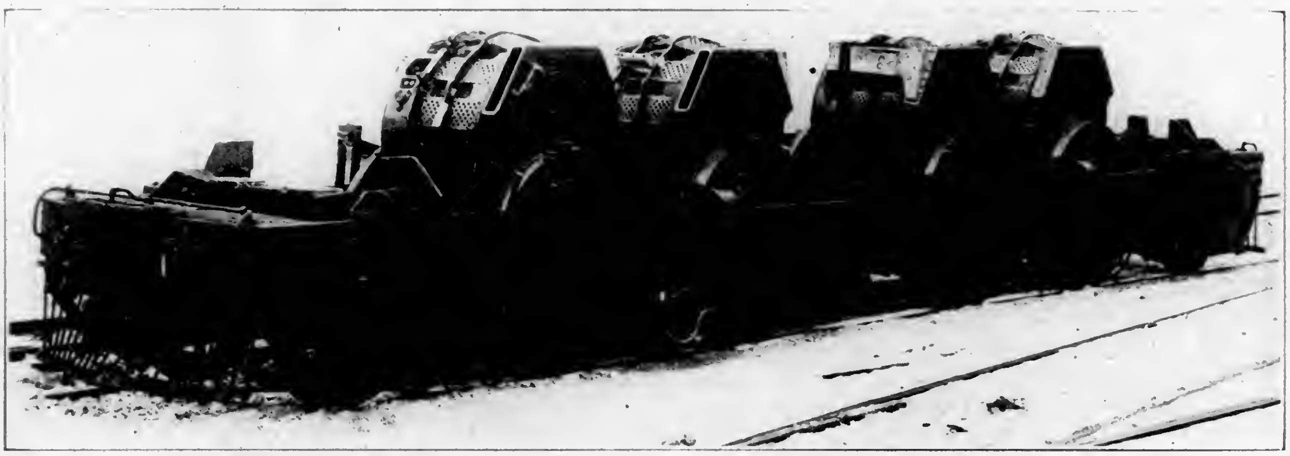
DRIVERS, SHOWING DRIVE THROUGH SPRINGS BETWEEN QUILL AND WHEEL.

Each locomotive is equipped with four Westinghouse 315 h.p. air cooled motors and Westinghouse non-automatic unit switch control. The gear ratio for the freight locomotives is 22 to 91, and for passenger locomotives 34 to 79. The former have a continuous tractive effort of 49,000 lbs. at 21 m.p.h., and the latter a tractive effort of 12,000 at 37½ m.p.h. The total weight of each locomotive is 260,000 lbs., distributed to give 48,000 lbs. on each driving axle.

ELECTRIC LOCOMOTIVES IN THE HOOSAC TUNNEL

BOSTON & MAINE R. R.

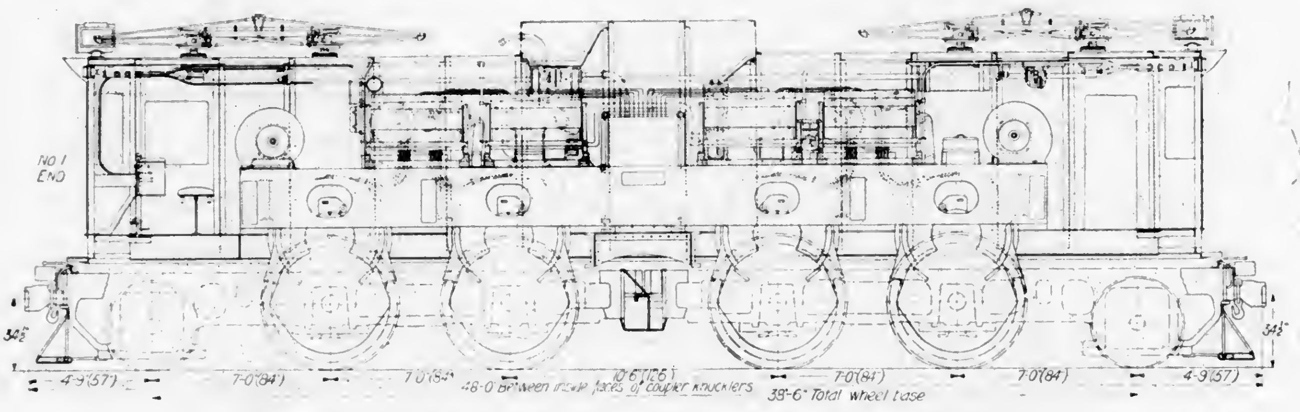
In the newly electrified Hoosac Tunnel, the Boston & Maine Railroad Company has in service five electric locomotives for hauling the trains and their steam locomotives with banked fires through the tunnel. This practically eliminates the obnoxious steam, smoke and gases incidental to steam operation. These locomotives have four geared motors, twelve wheels, and are designed for operation on 11,000 volts alternating current. Two are used for heavy freight service and the remaining three for combination passenger and light freight service.



ARTICULATED ELECTRIC LOCOMOTIVE WITH CAB REMOVED.

The electrified zone extends from Hoosac Tunnel Station, Mass., to North Adams, Mass., a distance of 7.92 miles, of which 4.75 miles are within the tunnel. The central zone of the tunnel has an almost level track 1,200 feet in length, with an ascending 0.5 per cent. grade up to this level track from both the east and west portals.

For passenger service, the locomotives were designed to handle trains having a maximum weight of 730 tons, inclusive of steam and electric locomotives, and to maintain a schedule time of 14 minutes between East Portal, Mass., and North Adams, Mass. The locomotives for freight service were built to handle heavy freight trains having a maximum weight of 2,000 tons, including both steam and electric locomotives, and are required to accelerate this tonnage on the 0.5 per cent. grade in the tunnel.



ELEVATION OF B. & M. ELECTRIC LOCOMOTIVE, SHOWING GENERAL ARRANGEMENT.

These locomotives are similar in every way to those built a little over a year ago for the New York, New Haven & Hartford Railroad, which were illustrated on page 245 of the June, 1910, issue of this journal. They incorporate a running gear consisting of two separate trucks, each having two pairs of 63 inch drivers and a radial pony truck. The motors are mounted on the truck frame over each driving axle and drive through gearing. The truck side frames follow the general design of the cast steel frames for steam locomotives, except that they are outside of the wheels. The side frames are joined at each end by a cast steel box section girder of sufficient strength to care for the stresses involved in bumping in freight service. The bumper girder at each end of the locomotive is equipped with an M. C. B. coupler mounted with a Westinghouse friction draft gear.

The adjacent bumper girders at the midlength of the locomotive are joined by a drawbar with a pin connection at each end. The eye in this bar is elongated at one end and the length of the bar is so arranged that it is impossible for the bar to be subjected to compression under severe bumping conditions. The three wheels on each side of each truck are equalized together. The longitudinal stability of the trucks is provided by the method of mounting the cab which is supported by eight spring-loaded friction plates, two plates resting on each end of the truck. This relieves the truck center pins of all the weight. This method of supporting the cab interposes two sets of springs in series between the rail and the cab and gives an exceptionally easy riding cab. To relieve the cab from possible pulling and bumping strains, the center pin of one truck is arranged with longitudinal clearance. This truck can not only rotate, but can also move longitudinally relative to the cab.

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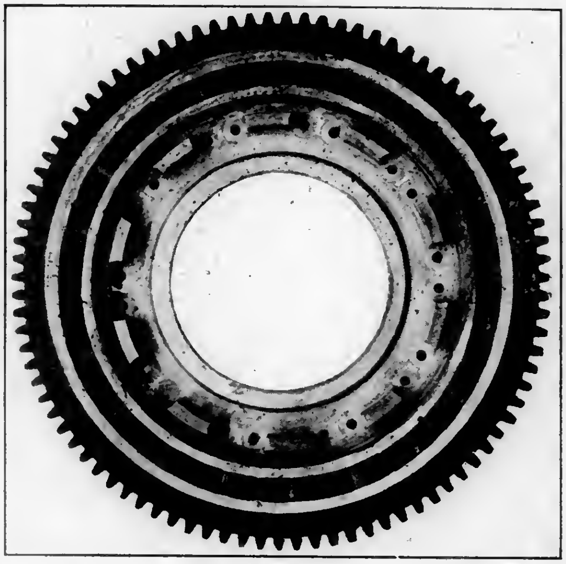
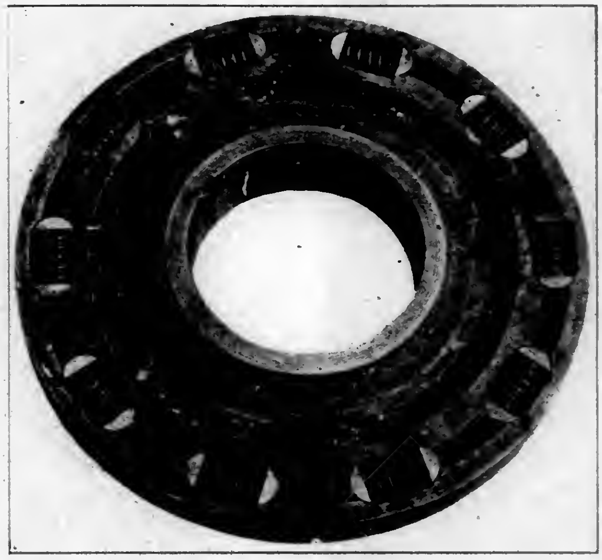
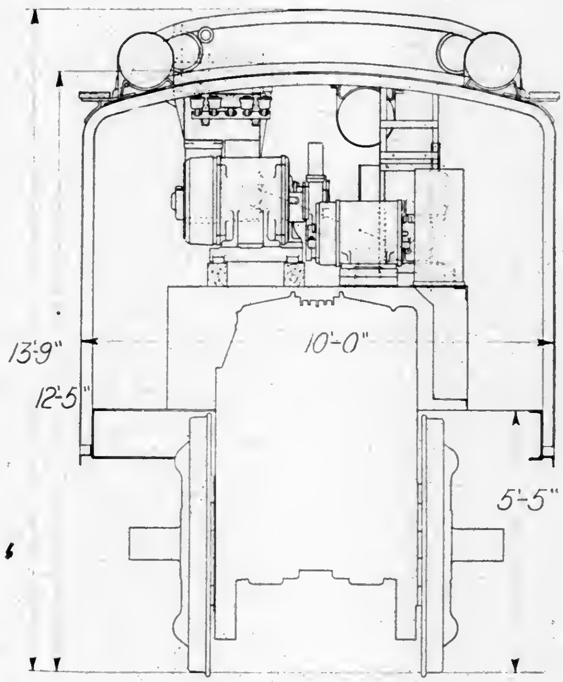




GEAR RIM AND CENTER, SHOWING FLEXIBLE DRIVE BETWEEN MOTOR PINIONS AND QUILL.



END ELEVATION OF LOCOMOTIVE.

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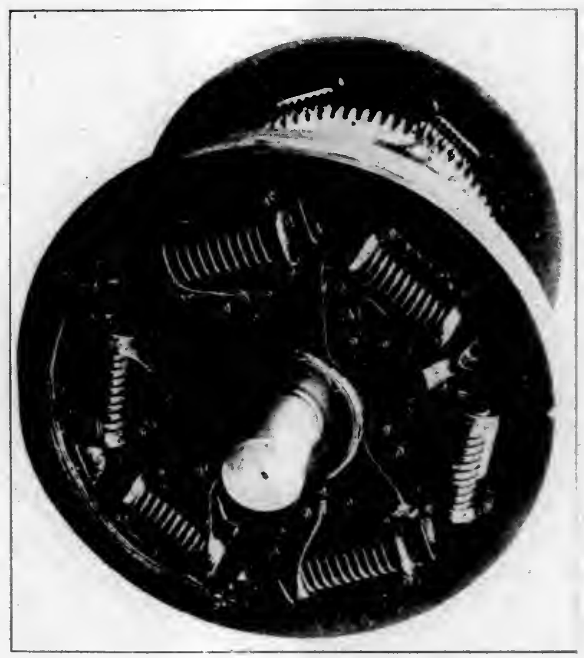

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CAB DETAILS OF 4-6-2 LOCOMOTIVE

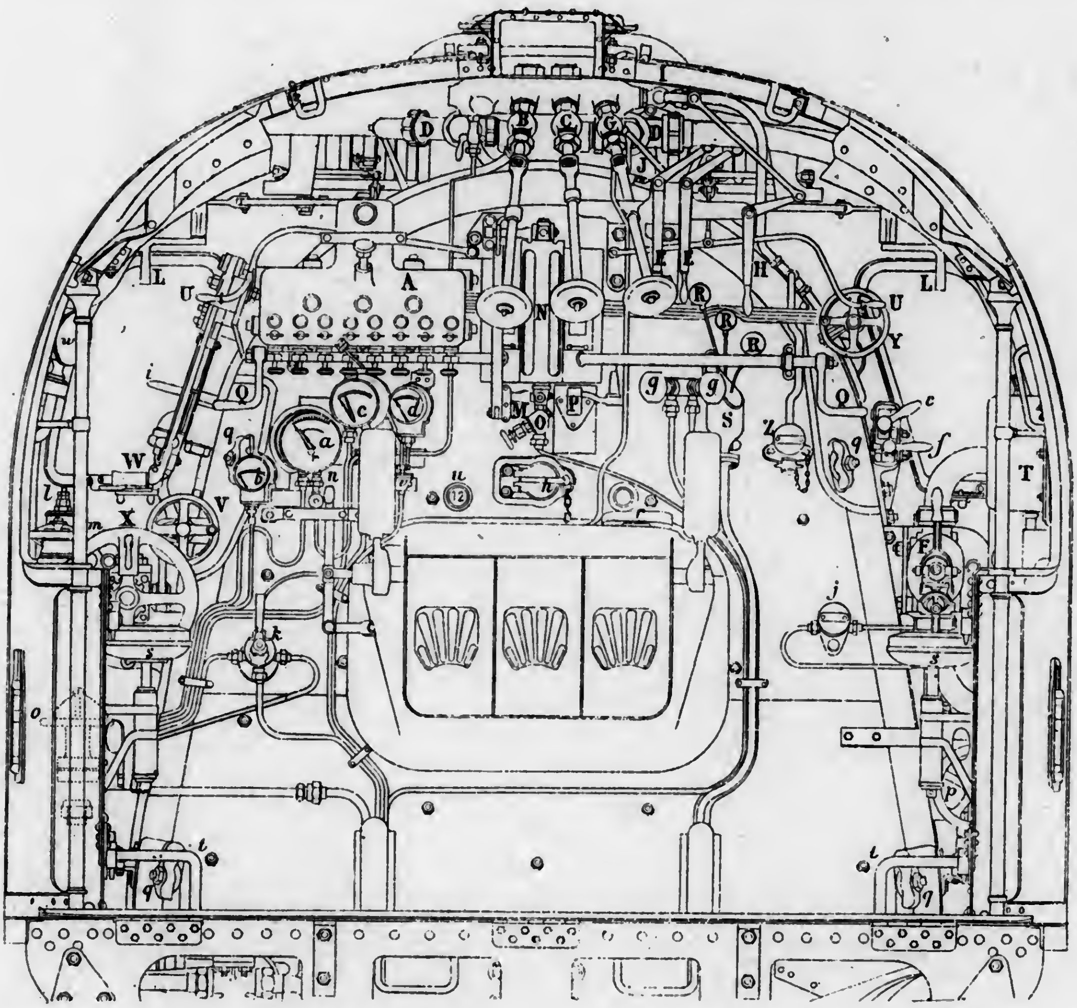
PARIS, LYONS & MEDITERRANEAN RY.

The extraordinary complication shown in the accompanying illustration of a foreign locomotive cab may convey a slight idea of what is demanded of an engineer engaged in handling a modern high speed passenger locomotive on European railways. The cab interior represents that of one of the new Pacific type locomotives recently completed for the Paris, Lyons and Mediterranean Railway, and the general arrangement must obviously appear unfamiliar when viewed in the light of American practice.

This engine is of the four-cylinder simple type, although in the operating details it follows closely that of the De Glehn compound which has remained the standard abroad for this service during the past decade or so. It will be noted that the equipment comprises a variable exhaust; manual control of the Schmidt superheater; control from the cab of ash pan dampers, and many other refinements not found in American locomotives. The large hydrostatic lubricator takes care of practically everything requiring lubrication, including the four cylinders, air pump and even the driving boxes. So far this road has not experienced any particular difficulty in lubricating where superheated steam is used, hence mechanical lubricators are not embodied in the design of these new engines.

A very prominent feature noticeable in connection with the general cab arrangement is the grouping of many important operating details on the right hand, or fireman's side of the engine. The injectors, for instance, are so located, as abroad, the fireman invariably controls the boiler feeding. He also takes care of the variable exhaust, handles the superheater damper and altogether assists more in the actual running of the engine than may be found anywhere in this country.

A very striking characteristic, which may be readily appreciated from a scrutiny of the illustration, is the disregard of comfort for the men embodied in the design. The cab seats are misnomers, and when using them it is almost impossible to see the road ahead. The engine crew, as a rule, remain on their feet throughout the run, and even this contingency is not prop-



EXPLANATION OF REFERENCE TABLE

A—General lubricator.
B—Lubricator steam valve.
C—Flue cleaner valve.
D—Injector steam pipes.
E—Steam control to injectors.
F—Injectors.
G—Air pump steam valve.
H—Blower valve handle.
I—Blower valve.
J—Sand box valve.
L—Cab ventilator handle.
M—Water glass.
N—Water glass shield.
O—Blow-off to water glass.
P—Water glass lamp bracket.
Q—Handle to water glass blow-off.
R—Gauge cocks.
S—Gauge cock drip pan.
T—Speed recorder.
U—Steam whistle.
V—Independent safety valve.
W—Throttle valve handle.
X—Screw reverse gear.
Y—Superheater control valve.
Z—Air tube blower.
a.—Boiler steam gauge.
b.—Straight air brake gauge.
c.—Automatic air brake gauge.
d.—Steam blower gauge.
e.—Outside cylinder cock lever.
f.—Inside cylinder cock lever.
g.—Water valves to ash pan.
h.—Firebox peep hole.
i.—Water valve to cylinder.
j.—Smoke consuming device.
k.—Hand sander.
l.—Automatic brake handle.
m.—Straight air brake handle.
n.—Firebox damper control.
o.—Variable exhaust control.
p.—Grate shaking device.
q.—Wash out holes.
r.—Oil can bracket.
s.—Cab seats.
t.—Foot rests.
u.—Boiler record.
v.—Lubricator drain pipe.
w.—Pyrometer.

erly provided for as the rounded shape of the cab sides necessitates a stooping position which is quite trying to maintain for any length of time.

They are very skilled in their work and obtain some really remarkable results. Engines of this type, with 400 tons behind the tender, are said to burn only 44 pounds of coal per mile, and despite their multitudinous parts are extremely light on oil. The latter reduced to the basis of American computation is not greater than $2.00 per thousand miles, and this despite the fact that four cylinders must be lubricated, with independent lubrication for each cylinder.

These economies may be very largely explained through the premium system which is universal on the railroads of France, and so extensive in scope that bonus payments are provided for practically everything, from making up lost time to saving box packing. When it is remembered that the pay of an engineer is not more than fifty dollars per month, and that it is possible to add some twenty dollars to this through judicious saving, it may be readily appreciated that the latter becomes a very important consideration. The negative results obtained by the premium system in the United States, where it has been tried, may be traced to the small amount in proportion to total pay which it is possible to earn under such systems. The men handling the engine herein illustrated do not object to the various cab ramifications, which might cause a grievance here, because they appreciate that through their intelligent use it is possible to add a considerable amount to their monthly pay checks.

In this effort they are, of course, tremendously assisted by the care exercised to provide proper upkeep for the locomotives. Their maintenance in France especially is fittingly viewed as a very serious matter, and nothing whatever is slighted or left undone. It may be possible that a realization of this fact on the part of the men conveys that with a perfect machine to work with perfect work may be logically expected from them. Whatever the secret may be, the fact must remain undisputed that the locomotive service over seas has been raised to practically the highest possible stage of efficiency.

A FIRELESS STEAM LOCOMOTIVE

A very novel locomotive design is shown in the accompanying illustration of a steam storage industrial locomotive, particularly useful where the fire risk is to be minimized.

This locomotive consists essentially of a large tank 84 in. in diameter and 16 ft. ½ in. maximum length, mounted on two pairs of 36 in. drivers, the cylinders, frames and other parts, ex-

STEAM STORAGE LOCOMOTIVE.

clusive of the boiler, being practically the same as on the usual locomotive. The tank is made of suitable strength for 200 lbs. pressure and is provided with a dome and small throttle valve of the usual type. A 4 in. dry pipe connects the throttle to a large Mason reducing valve in the front end from which branch pipes extend to each of the cylinders. The exhaust steam is carried out at the front of the saddle and through a pipe to the stack, a large separator being provided in the stack which takes out the water from the exhaust steam.

The cylinders are 18 in. x 18 in. and the reducing valve is set for 60 lbs. pressure. With this pressure the tractive effort of the locomotive is 9,720 lbs.

In operation, the tank is filled about half full of water and is then connected with a steam line from the boiler plant until the pressure equalizes. When this occurs, considerable steam will have been condensed, but the water will have been raised to the pressure and practically the temperature of the steam supply. As steam is used, of course, the pressure falls and more water is turned into steam. For the locomotive here shown, it is stated that under ordinary circumstances it will not have to be charged any oftener than a regular locomotive has to take water, or say two charges per day. The loss by radiation will not amount to more than 3 or 4 lbs. pressure per hour.

This locomotive has a total weight in working order of 77,100 lbs. The driving journals are 6 in. x 7 in., and the tank has a capacity of 530 cubic feet. The brake is operated by hand, a large vertical brake wheel being provided in the cab. It was designed and built by the Lima Locomotive & Machine Company, Lima, Ohio.

NATIONAL RAILWAY APPLIANCE ASSOCIATION

Preparations are now being made for the annual exhibition of railway appliances used in the construction and maintenance of steam and electric railways, which will be given by the National Railway Appliances Association, at the Coliseum and First Regiment Armory, in Chicago, March 18th to 23rd, inclusive, 1912. This is the week during which the American Railway Engineering Association will hold its thirteenth annual convention, and the Railway Signal Association will hold its spring meeting. The Railway Appliances Association has been incorporated under the name of National Railway Appliances Association, with offices at 537 So. Dearborn street, Chicago. The arrangement of the main floor space in the Coliseum will be practically the same as last year, but the balconies will not be used. In order to provide for the increasing demand for space, the First Regiment Armory, adjoining the Coliseum, has been leased, which will give an additional 16,000 square feet of floor space.

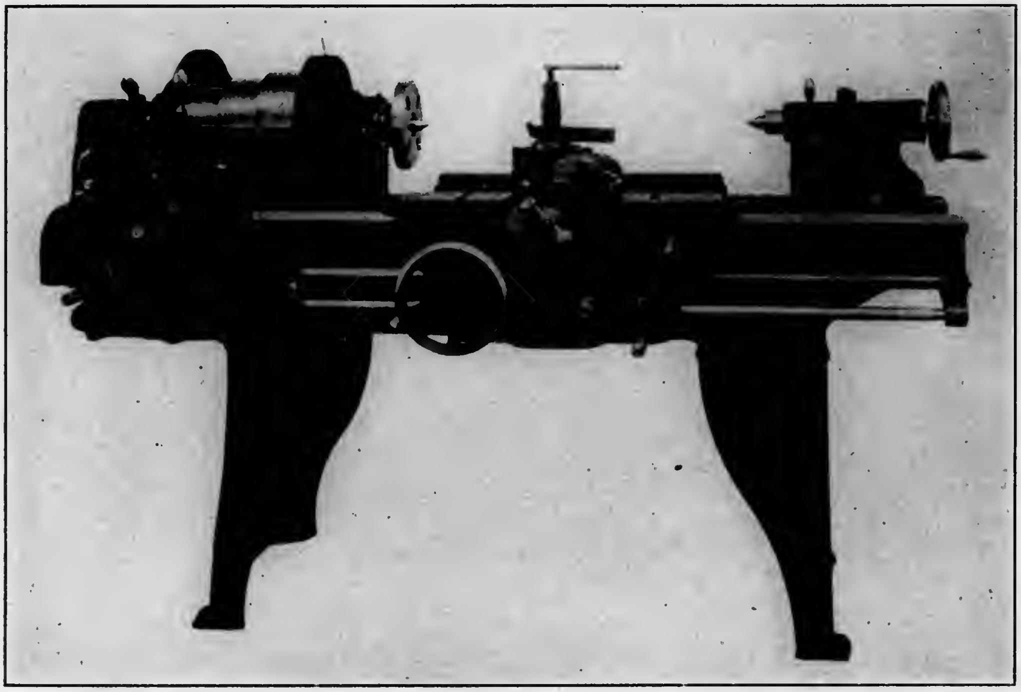
The price of the floor space will be 45 cents per square foot, the additional charge of five cents per square foot over last year having been made because of the necessity of buying fixtures this year, instead of renting them as heretofore. The first allotment of space will be made on or about November 1, 1911, by the Executive Committee of the Association. Therefore it is advisable to have all applications for space in the hands of the Secretary, Bruce V. Crandall, 1400 Ellsworth Bldg., 537 So. Dearborn street, Chicago, as early as possible.

The Pennsylvania to Use Concrete Poles.—To avoid interruptions by severe storms or fires from meadow grass, as well as for durability and appearance, the Pennsylvania Railroad has constructed a reinforced concrete pole line designed to carry sixty aerial wires and two 1½-inch lead-encased cables for its telegraph and telephone circuits on the north side of its tracks across the five miles stretch of swampy meadow land between Manhattan transfer and the portal of the tunnels leading into the new passenger station in New York.

Exports of Iron and Steel from the United States in the fiscal year just ended will probably be $235,000 000 in value, against $184,000,000 in the former high record year, 1908. The total for the ten months ending with April, the latest period for which details have been compiled by the Bureau of Statistics, Department of Commerce and Labor, is in round terms $190,-000,000, and if the May and June exports approximate in each case those of April, the total for the year will be fully $235,-0000,000.

THE NEW "MORRIS" 16 in. LATHE

The accompanying photographs illustrate a new 16 in. quick change engine lathe recently placed on the market by the John B. Morris Machine Tool Co. The machine, while conforming in general to the practice of the leading lathe builders, has a number of novel features incorporated in its design which tend to considerably increase the productive capacity. It is a tool intended for heavy duty service, and is characterized by great driving power, together with strength in details to suit.



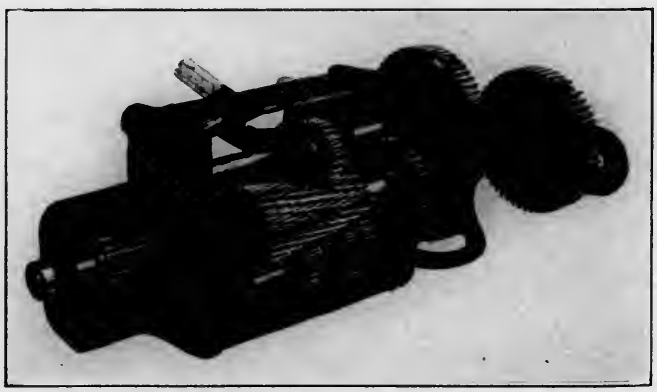
POWERFUL QUICK CHANGE ENGINE LATHE.

The driving cone, which is 3-stepped, has diameters 7⅛ in., 8⅝ in. and 10 in. respectively for a 3½ in. driving belt. The back gears are of the double friction type with ratios sufficient to give ample pulling power on large diameters and the frictions are of the toggle lever type, unusually large in diameter, and fitted with an automatic adjustment for wear. The spindle boxes are made of phosphor bronze and are oiled continuously from large oil wells in the pedestals. The front spindle bearing is 2¾ in. in diameter by 4½ in. long. The headstock is reinforced with an improved system of dropped longitudinal and cross ribs which are down below the shears of the bed. The reverse plate is carried on the outside of the head and is a double-walled one-piece casting in which the studs for the gears are supported at both ends.

In the quick change gear mechanism are found the usual cone and tumbler gear with a novel system of sliding gears through which 45 changes of feed or thread leads are obtained with the use of 21 gears. All feed changes are secured by means of the three levers shown on the front of the box, the one at the left being used only to secure the extreme range. The total range possible is from two to sixty threads per inch.

At the end of the lathe is seen the usual quadrant and quadrant gear for connecting up with the spindle so that it is possible to put on change gears to secure any special thread which might be required within the above range, making the machine capable of covering as wide a range of threads as can be obtained on a standard construction of engine lathes. A new feature in connection with this mechanism is the method of connecting it with the feed rod and lead screw. This is accomplished by means of a sliding gear operated by the knurled handle shown at the extreme right of the box, and is so arranged that when the lead screw is in operation the feed rod is at rest and vice versa. This construction makes the quick change box a complete mechanism within itself and permits it being taken off the bed without disturbing the adjustment of the lead screw or feed rod.

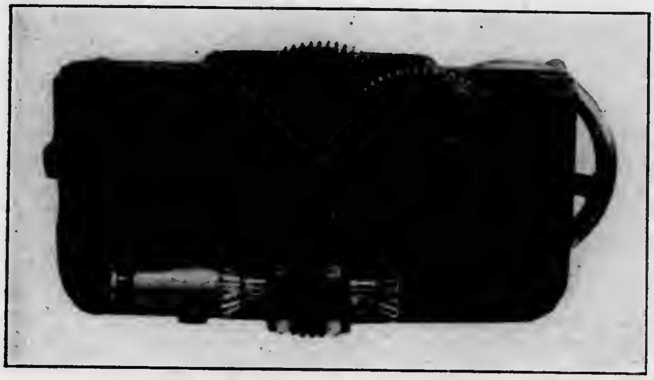
A one-piece box section casting forms the apron and all studs and gears are supported in the bearing at either end. It is supplied with the usual bevel gear reverse, which mechanism interlocks with the half nut, so that it is impossible to engage the lead screw and feed rod at the same time. To overcome the difficulty sometimes encountered in engine lathes due to the operator's inability to manipulate the revolving knurls for engaging feeds, owing to the high speed at which they revolve, a novel arrangement of clutches is employed. The frictions are of the expanding ring type, 5 in. in diameter, and engaged by means of toggle lever movement which insures ample driving power under the heaviest cuts. The shifting mechanism for these frictions consists of a single crank handle shown on the front of the apron. When this lever is thrown to the right it engages the longitudinal feed, and when it is thrown to the left it engages the cross feed. Since this lever is stationary at all times, it enables the operator to work up to a shoulder without the necessity of throwing out the feed and running up the carriage by hand; and in addition to this it is in a particularly convenient position for the operator to manipulate at all times. Provision



QUICK CHANGE GEAR MECHANISM.

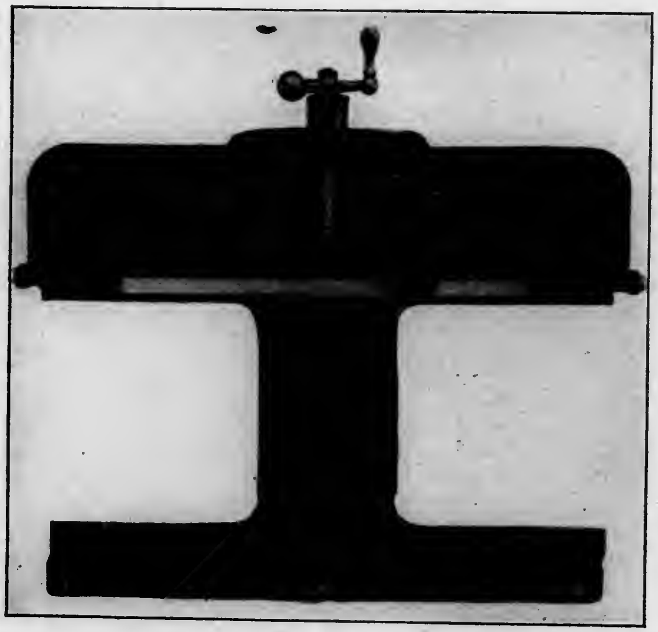
is made in the shape of a positive stop, which makes it impossible to throw the lever from one feed to the other without first pulling out the plunger pin in the handle, thus making it impossible to pass directly from the longitudinal to the cross feed, or *vice versa*.

The carriage, which has a bearing 26½ in. long on the bed, is carried on a "V" in front and on a flat surface at the back of the bed. It is held in position by a long flat clamp at the back,



DETAILS OF APRON GEARING.

and by means of two taper gibs at the front which bear on the machined surface directly under the front "V." These gibs from their location make it impossible for the carriage to lift or climb the "V" under any conditions, and at the same time will not throw the carriage out of alignment if not properly adjusted. The front "V" is unusually large, being 1½ in. in width, and with the wide flat bearing at the back gives the carriage a total effective bearing area of from two to three times that usually found on lathes of this size. The bridge is very wide and drops down in a deep double box section between the shears. Since the ways for the tailstock are dropped down



BOTTOM VIEW OF CARRIAGE.

below the ways for the carriage, it is not necessary to notch the bridge for clearance, and thus its rigidity is maintained.

The compound rest is made heavy to withstand the strains imposed upon it by the modern high speed steels. The clamping device for the swivel is of a new construction operated by a single belt which is located convenient to the operator. The clamping mechanism consists of a "V"-shaped clamping ring of a similar construction to that found on round column radial drills. This device, in addition to being very effective, leaves the bottom slide more rigid than it would be with the "T"-slot turned in it, and at the same time permits of very quick adjustment of the compound rest.

An unusually rigid construction is employed in the bed, which is 11¾ in. deep and 14½ in. wide. The front cross girth, which is directly under the front spindle bearing, extends clear up to the top of the ways in order to resist the twisting strain on the bed at this point. The legs are set in from the ends of the bed, thus shortening the span between supports on the bed and making use of the familiar cantilever form of construction. The tailstock is very massive of a box section and is arranged with the usual type of set-over for turning tapers. Its spindle is of steel 2 3/16 in. diameter and is clamped by means of a taper plug of the same construction as that usually found on the overarm of a milling machine. The tailstock is clamped to the bed by means of two large bolts coming up directly in front of and behind the tailstock spindle. These bolts reach to the top of the tailstock where the nuts are in a convenient place for the operator.

This lathe swings 16½ in. over shears, and 10 in. over carriage, and with a six-foot bed takes 2 ft. 8 in. between centers. With a six-foot bed the weight is approximately 2,100 lbs. That the machine is capable of continuous operation under heavy cuts will be evidenced by the statement that it will handle, without any signs of distress, a cut ¼ in. deep by ⅛ feed in 60 point carbon steel at a peripheral speed of 75 feet per minute.

M. M. AND M. C. B. CONVENTIONS

At a joint meeting of the executive committees of the Master Mechanics', Master Car Builders' and Railway Supply Manufacturers' Association, held at the Belmont Hotel, New York, October 24, it was decided to hold the 1912 conventions at Atlantic City. The Master Mechanics' Association will meet June 12, 13 and 14, and the Master Car Builders' Association, June 17, 18 and 19. At the suggestion of railway men it was decided to make a change in the entertainment features and the manner of handling them. This change is expected to do away with all entertainment fatures except the annual ball game. Informal dances will be held instead of the two grand balls. It is also understood that members of the two associations are to be given preference in the assignment of the accommodations at the headquarters hotel, but applications for accommodations to come under this preference must be in by December 1, 1911.

QUARTERS FOR DINING CAR EMPLOYEES

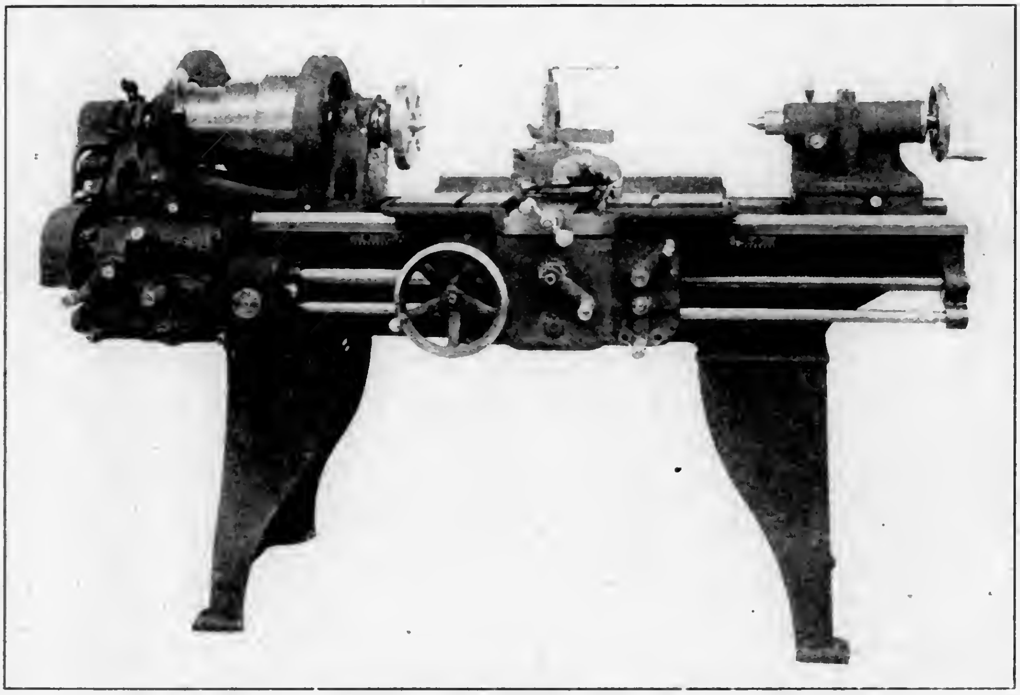
At Winnipeg, Calgary and Vancouver the Canadian Pacific in connection with the dining car department has in use three new buildings which have been erected at a cost of $15,000 for lodgings for the employees of the dining car department. Coming into these cities after a long run the men will not have to look up a hotel or boarding house, but will go to the new buildings. These houses are built to accommodate sixty-two employees and are of the most modern construction in every respect. Everything is free, including the laundry. Conductors, chefs and waiters all have separate quarters, which include baths, bedrooms, reading rooms, libraries, cardrooms and billiard rooms. Gardens beautify the premises and the men have all the comforts of home. It is compulsory for the men to take a bath and a change of underwear after each trip and a check system has been installed to insure that the men comply with this rule. When a car is called away on short notice at night it is not necessary to seek for a crew as the men are right at hand when needed. It is expected that the C. P. R. will build these houses at all divisional points.

THE NEW "MORRIS" 16 in. LATHE

The accompanying photographs illustrate a new 16 in. quick change engine lathe recently placed on the market by the John B. Morris Machine Tool Co. The machine, while conforming in general to the practice of the leading lathe builders, has a number of novel features incorporated in its design which tend to considerably increase the productive capacity. It is a tool intended for heavy duty service, and is characterized by great driving power, together with strength in details to suit.

at rest and vice versa. This construction makes the quick change box a complete mechanism within itself and permits it being taken off the bed without disturbing the adjustment of the lead screw or feed rod.

A one-piece box section casting forms the apron and all studs and gears are supported in the bearing at either end. It is supplied with the usual bevel gear reverse, which mechanism interlocks with the half nut, so that it is impossible to engage the lead screw and feed rod at the same time. To overcome the difficulty sometimes encountered in engine lathes due to the operator's inability to manipulate the revolving knurls for engaging feeds, owing to the high speed at which they revolve, a novel arrangement of clutches is employed. The frictions are of the expanding ring type, 5 in. in diameter, and engaged by means of toggle lever movement which insures ample driving power under the heaviest cuts. The shifting mechanism for these frictions consists of a single crank handle shown on the front of the apron. When this lever is thrown to the right it engages the longitudinal feed, and when it is thrown to the left it engages the cross feed. Since this lever is stationary at all times, it enables the operator to work up to a shoulder without the necessity of throwing out the feed and running up the carriage by hand; and in addition to this it is in a particularly convenient position for the operator to manipulate at all times. Provision



POWERFUL QUICK CHANGE ENGINE LATHE.

The driving cone, which is 3 stepped, has diameters $7\frac{1}{8}$ in., $8\frac{5}{8}$ in. and 10 in. respectively for a $3\frac{1}{2}$ in. driving belt. The back gears are of the double friction type with ratios sufficient to give ample pulling power on large diameters and the frictions are of the toggle lever type, unusually large in diameter, and fitted with an automatic adjustment for wear. The spindle boxes are made of phosphor bronze and are oiled continuously from large oil wells in the pedestals. The front spindle bearing is $2\frac{3}{4}$ in. in diameter by $4\frac{1}{2}$ in. long. The headstock is reinforced with an improved system of dropped longitudinal and cross ribs which are down below the shears of the bed. The reverse plate is carried on the outside of the head and is a double-walled one-piece casting in which the studs for the gears are supported at both ends.

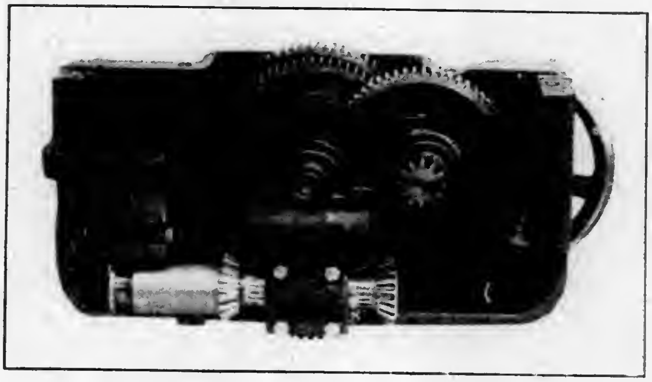
In the quick change gear mechanism are found the usual cone and tumbler gear with a novel system of sliding gears through which 45 changes of feed or thread leads are obtained with the use of 21 gears. All feed changes are secured by means of the three levers shown on the front of the box, the one at the left being used only to secure the extreme range. The total range possible is from two to sixty threads per inch.

At the end of the lathe is seen the usual quadrant and quadrant gear for connecting up with the spindle so that it is possible to put on change gears to secure any special thread which might be required within the above range, making the machine capable of covering as wide a range of threads as can be obtained on a standard construction of engine lathes. A new feature in connection with this mechanism is the method of connecting it with the feed rod and lead screw. This is accomplished by means of a sliding gear operated by the knurled handle shown at the extreme right of the box, and is so arranged that when the lead screw is in operation the feed rod is

QUICK CHANGE GEAR MECHANISM.

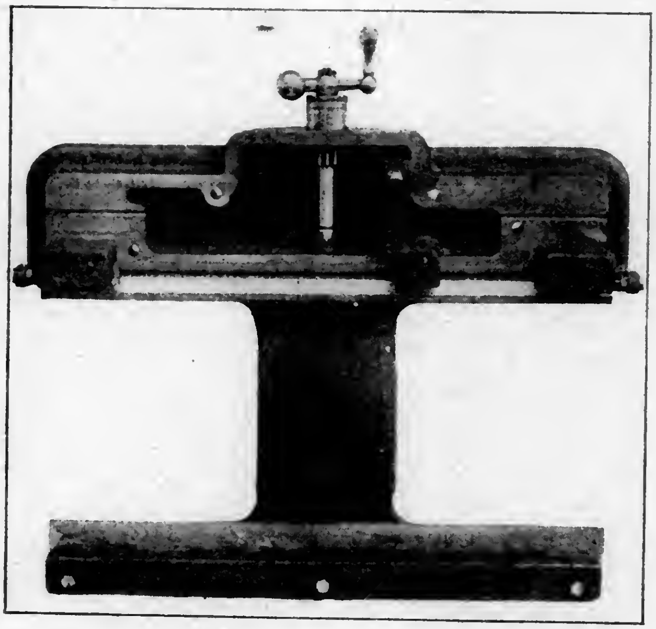
is made in the shape of a positive stop, which makes it impossible to throw the lever from one feed to the other without first pulling out the plunger pin in the handle, thus making it impossible to pass directly from the longitudinal to the cross feed, or *vice versa.*

The carriage, which has a bearing 26½ in. long on the bed, is carried on a "V" in front and on a flat surface at the back of the bed. It is held in position by a long flat clamp at the back,



DETAILS OF APRON GEARING.

and by means of two taper gibs at the front which bear on the machined surface directly under the front "V." These gibs from their location make it impossible for the carriage to lift or climb the "V" under any conditions, and at the same time will not throw the carriage out of alignment if not properly adjusted. The front "V" is unusually large, being 1½ in. in width, and with the wide flat bearing at the back gives the carriage a total effective bearing area of from two to three times that usually found on lathes of this size. The bridge is very wide and drops down in a deep double box section between the shears. Since the ways for the tailstock are dropped down



BOTTOM VIEW OF CARRIAGE.

below the ways for the carriage, it is not necessary to notch the bridge for clearance, and thus its rigidity is maintained.

The compound rest is made heavy to withstand the strains imposed upon it by the modern high speed steels. The clamping device for the swivel is of a new construction operated by a single belt which is located convenient to the operator. The clamping mechanism consists of a "V"-shaped clamping ring of a similar construction to that found on round column radial drills. This device, in addition to being very effective, leaves the bottom slide more rigid than it would be with the "T"-slot turned in it, and at the same time permits of very quick adjustment of the compound rest.

An unusually rigid construction is employed in the bed, which is 11¾ in. deep and 14½ in. wide. The front cross girth, which is directly under the front spindle bearing, extends clear up to the top of the ways in order to resist the twisting strain on the bed at this point. The legs are set in from the ends of the bed, thus shortening the span between supports on the bed and making use of the familiar cantilever form of construction. The tailstock is very massive of a box section and is arranged with the usual type of set-over for turning tapers. Its spindle is of steel 2 3/16 in. diameter and is clamped by means of a taper plug of the same construction as that usually found on the overarm of a milling machine. The tailstock is clamped to the bed by means of two large bolts coming up directly in front of and behind the tailstock spindle. These bolts reach to the top of the tailstock where the nuts are in a convenient place for the operator.

This lathe swings 16½ in. over shears, and 10 in. over carriage, and with a six-foot bed takes 2 ft. 8 in. between centers. With a six-foot bed the weight is approximately 2,100 lbs. That the machine is capable of continuous operation under heavy cuts will be evidenced by the statement that it will handle, without any signs of distress, a cut ¼ in. deep by ⅛ feed in 60 point carbon steel at a peripheral speed of 75 feet per minute.

M. M. AND M. C. B. CONVENTIONS

At a joint meeting of the executive committees of the Master Mechanics', Master Car Builders' and Railway Supply Manufacturers' Association, held at the Belmont Hotel, New York, October 24, it was decided to hold the 1912 conventions at Atlantic City. The Master Mechanics' Association will meet June 12, 13 and 14, and the Master Car Builders' Association, June 17, 18 and 19. At the suggestion of railway men it was decided to make a change in the entertainment features and the manner of handling them. This change is expected to do away with all entertainment fatures except the annual ball game. Informal dances will be held instead of the two grand balls. It is also understood that members of the two associations are to be given preference in the assignment of the accommodations at the headquarters hotel, but applications for accommodations to come under this preference must be in by December 1, 1911.

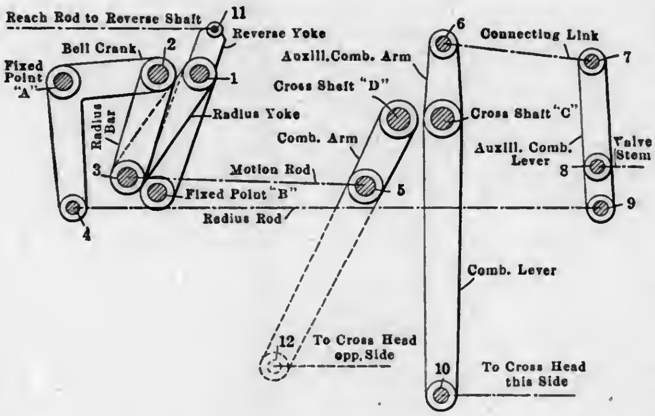
QUARTERS FOR DINING CAR EMPLOYEES

At Winnipeg, Calgary and Vancouver the Canadian Pacific in connection with the dining car department has in use three new buildings which have been erected at a cost of $15,000 for lodgings for the employees of the dining car department. Coming into these cities after a long run the men will not have to look up a hotel or boarding house, but will go to the new buildings. These houses are built to accommodate sixty-two employees and are of the most modern construction in every respect. Everything is free, including the laundry. Conductors, chefs and waiters all have separate quarters, which include baths, bedrooms, reading rooms, libraries, cardrooms and billiard rooms. Gardens beautify the premises and the men have all the comforts of home. It is compulsory for the men to take a bath and a change of underwear after each trip and a check system has been installed to insure that the men comply with this rule. When a car is called away on short notice at night it is not necessary to seek for a crew as the men are right at hand when needed. It is expected that the C. P. R. will build these houses at all divisional points.

STYLE "B" PILLIOD LOCOMOTIVE VALVE GEAR

A number of important changes have recently been made in the details of the Pilliod locomotive valve gear, which are of much interest in view of the ingenuity displayed in the elimination of formerly existing parts, and the fact that in the re-design, known as style "B," the imparting movement, obtained from the crosshead only, has now become permanently indentified with the gear. This clever mechanism has been described and illustrated in this journal,* and while basically it remains the same, it has been so simplified and re-arranged that the claim advanced that all objectionable features which may be found in any other gear have been eliminated seems to be well founded.

Referring to the accompanying drawing, a brief description showing how results are obtained is necessary as a preliminary



to the study of the motion: Point (10) of the combination lever is connected to the crosshead with a union link. The combination lever transmits the motion through the auxiliary combination arm to the point (6) which is connected to point (7) of auxiliary combination lever by means of the connecting link. This gives the lap and lead travel of the valve through point (8) which is connected to the valve stem. Point (C) is a cross shaft extending across the engine to opposite crosshead through cross shaft (D). The motion is transmitted to point (5) which is connected to point (3) by the motion rod. The oscillation of the radius yoke around point (1) raises and lowers the radius bar. This is connected at point (2) to the bell crank which in moving around point (A) transmits the motion of the radius rod through point (4). The radius rod in turn acts upon the auxiliary combination lever and gives the accelerated movement to the valve through point (8) which is connected to the valve stem. Point (11) is connected to the reverse lever by the reach rod. The movement of the reverse yoke, at the various points of cut off around point (B) will cause point (3) to move in various planes.

The question has been raised at various times as to whether or not there is more distortion from a crosshead connected gear than from a crank and crosshead connected, and in this connection it may be asserted that such distortion cannot possibly exist in the former construction, as if present it would not be possible to keep the piston within the cylinder. It makes no difference what position the wheel or main crank is in, the piston must keep within its limits of travel. The angularity of the main rod always remains the same, and whether the centre line of axles is up or down the piston will travel to the exact point, or the same point from the front end of the 90 degree position of the crank, and cannot possibly be modified.

The main crank could move from the center line of the cylinders 3 in. below or 3 in. above, and it would not affect the complete stroke of the piston. The piston will travel the same identical distance from the end of the stroke to the 90 degree travel of the crank, regardless of the above variation. Admitting this to be true there can be no distortional effect in a crosshead connected gear, because while one piston is in mid position the other is in natural position, or at the completion of the stroke. The piston must travel the same distance at all times, and the valve gear maintains its same relative position regardless of the crank travel. It is well established that the combination lever of the Walschaert valve gear requires no modification within or during its operating period, but it is necessary to constantly change the eccentric rod and eccentric crank connection of the main pin to maintain uniform steam distribution.

In the crank and crosshead connected gears in practical use the valve gear frame is attached to the engine frame and the movement of the engine up and down on its springs changes the position of the valve gear in relation to the eccentric crank connection. For instance, if the locomotive was stationary and raised on its springs it would raise the gear and change the angle of the eccentric rod, since the eccentric crank, which is attached to the main driver would remain stationary, thereby causing the link to be drawn toward the eccentric crank. If the engine on the other hand were lowered on the springs the link would be moved away from the eccentric arm thus distorting the valve movement. This could, of course, happen when the engine is taking curves, or running over irregularities in the track.

Referring to the diagramatic sketch it will be easily seen that when the line of motion is changed by the engine settling 2½ in. the eccentric rod on the bottom quarter will be long, and short on the top quarter. If made short on the long side it will be doubly short on the short side and *vice versa*, and hence in attempting to square the gear it must be done by changing the crank circle. The style "B" gear was designed to overcome these objectionable features and at the same time give as good results as now obtainable with any outside connected gear and with no more wearing surfaces.

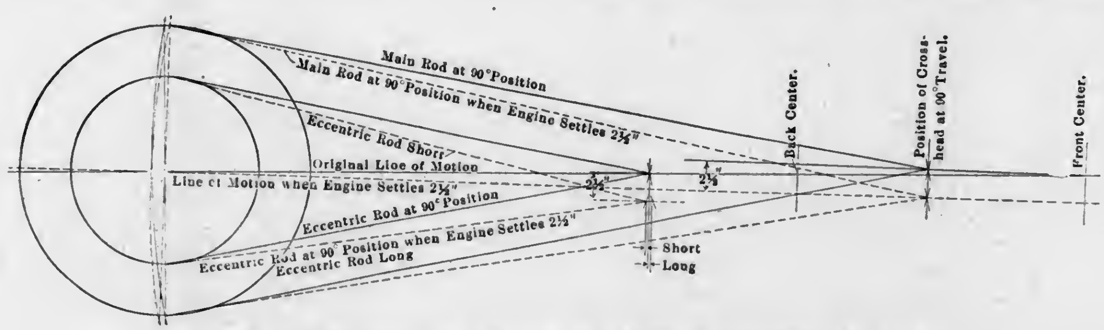


DIAGRAM SHOWING EFFECT OF VARIATION OF CENTERS OF CYLINDERS AND AXLES.

The new gear will no doubt be studied with interest by those who while satisfied with economy and efficiency results obtained with the Stephenson and Walschaert, still desire a gear which is free from the objections commonly made to those types, and one that can be applied to old power at a minimum cost. It will be of special interest to those who contemplate replacing the link motion with some form of outside gear as it can be applied without any modification of the engine. The Pilliod Brothers Co., of Toledo, O., manufacturers of the gear, say

* See AMERICAN ENGINEER, Jan., 1911, p. 22.

that it can be applied in 48 hours, this, of course, largely resulting from the fact that new main crank pins are not required. All parts, including frames, are standard for any type or class of engine, either inside or outside admission, with the exception of the combination lever, which differs in length according to the piston stroke.

In the re-design careful attention has been given to the proper proportion of the parts to insure the necessary strength throughout. The liability to failure in service, however, is extremely remote, as the arrangement being entirely without eccentric straps, link block pins, etc., cannot be identified with those well known sources of trouble. The accessibility of the gear to inspection is also a very important part, and the fact that practically nothing is concealed would no doubt result in the early discovery of a defect which might escape observation in other types. The details have been worked out with care, especially those in connection with lubrication. Each bearing has an oil cellar of special design, automatic in its feed, and so arranged that any sediment which might pass with the oil from the outside can in no way get into the bearings. The roundhouse men cannot make any change in the gear as there are no rods to lengthen or shorten.

In addition to the above style "B" gear which it is the intent of the manufacturers to feature as the ideal motion for all conditions they have also designed what is known as style "C," which will interest those who want a crank and crosshead connected gear without links or blocks. This is an outside gear with the same number of parts and bearings as the Walschaert, and differing from it only in that the links and blocks are replaced with a reverse of the Marshall type. The elimination of these latter parts would suggest that the cost of maintenance should be less, but the design retains the crank connection, and in general does not embody the feature of simplicity which has been pointed out in connection with the style "B" gear.

AN INTERESTING SUPERHEATER LOCOMOTIVE performance is reported by the C. N. R. locomotive 266, built by the Montreal Locomotive Works, and equipped with the Schmidt superheater, which ran 378 miles from Edmonton to North Battleford and back to Vermilion with six or seven coaches on a total coal consumption of about eight tons, this efficiency being largely due to the superheater.

A TRUCK CRANE OF GENERAL UTILITY

The urgent need for a device to handle with expedition and at low cost material of any description which must be moved from place to place within moderate confines of space has been long apparent, not only in connection with the larger shops, but equally so with locomotive terminals and at storehouse yards, etc. To solve the problem the General Electric Company is now placing on the market what it has designated as the "Battery Truck Crane," an electric vehicle which has a swinging crane mounted on the front end. The crane hook is raised and lowered by a one-ton hoist mounted on the front end just back of the crane, the motors driving the hoist and the vehicle being operated from a storage battery mounted on the rear end.

THE BATTERY TRUCK CRANE.

The time, money and step-saving applications of this crane may be classed under three heads—hoisting, hoisting and carrying on the hook, and towing trailers, yet a given movement of material may involve two or all of these. In case where material which may be subdivided into parcels of one ton or less, has to be deposited within a 6 or 8-foot radius, and this action does not require that the parcel be moved through a vertical distance of over 10 feet, the machine is brought into an advantageous position; the brakes are set, and the vehicle remains stationary as the boom of crane moved back and forth between the picking up and depositing points. In this manner the battery truck crane may be employed to load or unload box cars, gondola cars, etc., and a considerable saving effected both in time required and the number of men employed.

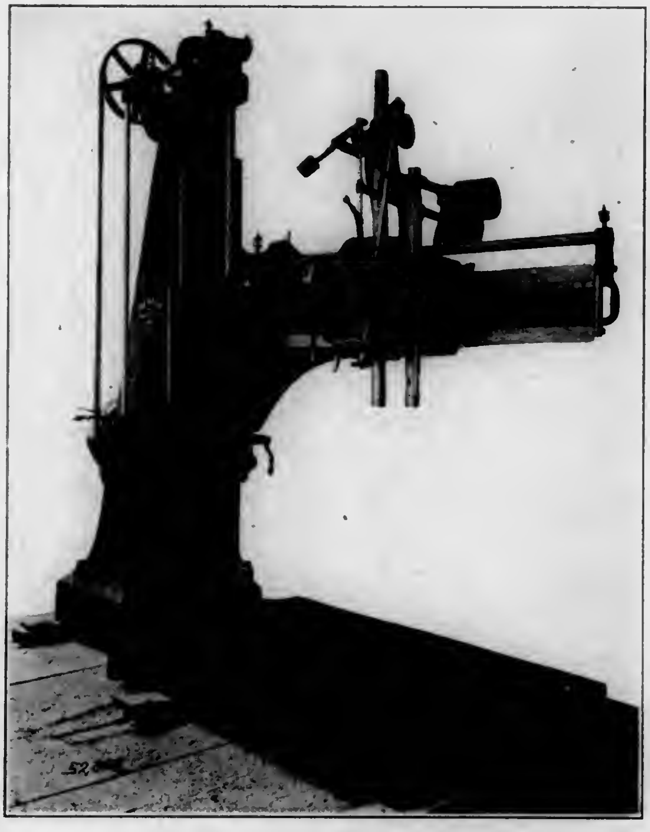
When material, in small or large quantities, has to be moved less than 400 feet or, in small quantities, to any distance, the article is lifted by the hook, conveyed to its destination by the vehicle, and placed on the floor, on a rack, or a high pile, as desired. The short wheel base permits making short turns, so this machine may readily be driven about shop aisles, congested piers or among piles of material in a storage yard. By this pick up and run method sixty 800-lb. barrels of plumbago were moved 300 feet in one hour, only one helper being required; one hundred and fifty 300-lb. boxes of rubber were conveyed 75 feet and loaded into a box car in 50 minutes, three boxes slung together and a round trip made every minute. In a storeroom boxes of angle and flat iron weighing about 1,000 lbs. each were carried 30 feet and stacked in sorted and orderly piles at the rate of 40 boxes an hour.

For the miscellaneous transfer of large quantities of package freight or other material through a distance of about 400 feet the best procedure is to use the battery truck crane to tow trailer in trains of about four. The number of trailers per train and the number of trains will depend upon the distance, character of load and time taken to load and unload the trailers. Twelve is the usual number, and these are divided into three trains. Thus the battery truck crane keeps 600 sq. ft. of loading deck working to its maximum capacity. This would be equal to a single vehicle 5 feet wide by 120 feet long, or to twelve individual power operated trucks each having 50 sq. ft. of space for carrying material.

The truck crane is designed for a high drawbar pull, its maximum being 2,000 lbs., and equal to that of a five-ton locomotive on rails, sufficient to spot a car and to readily handle loads of from five to eight tons on trailers.

HIGHLY DEVELOPED RADIAL DRILLING AND TAPPING MACHINE

The interesting machine herein illustrated is a prominent example of the development which the Newton Machine Tool Company, of Philadelphia, Pa., has brought about through recent redesign of several items in its output, several examples of which have previously been noted in these columns. It is worthy of special consideration, in view of the fact that it embodies many distinctive points which must necessarily appeal to those who use this particular machine tool.



NEWTON DRILLING AND TAPPING MACHINE.

A study of the design indicates primarily a recognition of the requisite that the framework should be sufficiently heavy and so proportioned as to successfully resist all vibrations of its own, so far as practical. That is to say, that while vibrations to a certain extent are unavoidable, still there should always be sufficient strength and solidity in the frame, so that the machine's vibrations will not materially affect the working qualities of other machines in close proximity to it. Where the framework, so called, which in the case of this tool may be roughly divided into work base, upright and arm, is light and weak, so that its own necessary vibrations become a tremble, then the good working qualities of the machine itself will not only be affected, but the tremble, when a uniform motion is kept up, will become an impulse like that of a pendulum and communicate itself to other parts of the shop. It is very evident that in the admirable proportions of the design under consideration, all such vibrations have been eliminated, or at least minimized to a degree which renders them of no import.

The arrangement of the various parts is of the simplest nature, and the tool generally is free from the flimsy refinements which characterize many others intended for the same line of work. The arm saddle has square lock bearings on the upright and there is a reversing fast vertical traverse. The trunnions are mounted in roller caged bearings, and every attempt has been made to produce this part in the most substantial and rigid form.

The machine is particularly adapted to drilling and tapping holes as the tapping spindle revolves at a reduction of 2¼ to 1 to the speed of the drilling spindle by which it is driven. In operation the drilling spindle with the drill in place is located, the hole drilled, and one revolution of the hand wheel, measured by an index on the dial, brings the tapping spindle with the tap in place over the already drilled hole. The drive to the tapping spindle is engaged for the reverse motions by the clutch operated by the small lever.

There are four changes of speed by means of a cone in addition to two to one back gears and four changes of gear feed to the spindle with adjustable automatic release. The spindle is counterweighted and has hand adjustment. The diameter of the individual spindles is 2 13/16 in.; distance from center of trunnion to center of inner or drilling spindle, 64 in.; length of feed, 17 in.; maximum distance from base to the center of spindle, 81 in.; size of work base, 7 ft. by 4 ft.

SCIENTIFIC MANAGEMENT

At a recent joint meeting of the Franklin Institute and the American Society of Mechanical Engineers a paper was read by Wilson E. Symons, of Chicago, combatting the Brandeis theory that by scientific management the railroads could save $1,000,000 per day. Mr. Symons took the attitude that the practical experience of railroad men had already reduced the costs of operation to a minimum that could not be reduced by "mere theorists."

In the ensuing discussion, Samuel Vauclain, vice-president of the Baldwin Locomotive Works, agreed generally with Mr. Symons. As the prices of materials are standard, the saving of $1,000,000 per day, if made at all, he said, would have to come out of the pockets of the workmen. "I believe in scientific management," he said, "but I do not believe in espionage that binds men down and makes them feel that they are mere automatons, driven by their employers, just to get the greatest amount of work out of them. Nothing is so scarce in this country as good labor, and it should be rewarded."

THE TENTH ANNUAL CONVENTION of the National Machine Tool Builders' Association was held at the Hotel Astor, New York, Tuesday and Wednesday, October 10th and 11th. The following officers were elected: President, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, Fred A. Geier, Cincinnati Milling Machine Co., Cincinnati, Ohio; second vice-president, A. T. Barnes, W. F. & John Barnes Co., Rockford, Ill.; treasurer, A. E. Newton, Prentice Bros. Co., Worcester, Mass.; secretary, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. The next semi-annual or spring meeting will be held in Atlantic City, N. J.

COPPER MAY BE WELDED by the use of a mixture of equal parts of boracic acid and phosphate of soda. The mixture is used in the same manner as in welding iron or steel, but should first be dried.

SOME EXPERIMENTS WITH TRUCKS

In the summer of 1910 an extremely valuable series of tests were conducted by Professor Louis E. Endsley, of Purdue University, to determine the running qualities of freight car trucks that are held reasonably square as compared with those constructed in such a way as to be free to get out of square. These tests, which have been fully described and illustrated in this journal,* were on invitation of the American Steel Foundries at Granite City, Ill., and were probably the most thorough in scope ever attempted to get at the real facts in connection with the subject.

Supplementing this information, however, George G. Floyd, mechanical engineer of that company, who collaborated with Professor Endsley in the tests, presented a paper before the September meeting of the Western Railroad Club in which further details of a most interesting and valuable character were made apparent. Mr. Floyd said in part as follows:

There were many things developed in the tests in the way of incidentals—sidelights, I might say—apart from the main tests, that are not fully set forth in the published report. It is my purpose to discuss some of these incidentals. After our investigation of the square and loose truck in service and before the testing plant was built, we had formed certain conclusions as the result of the investigation, as well as some opinions based upon the statements, experience and judgment of several railway engineers. While these conclusions and opinions had to be revised somewhat after the tests were run, our conclusions were in the main correct as to theory and as to what the results might be, and had to be revised only because the material effects had been somewhat underestimated.

For instance, it did not take long to discover that trucks in service did get out of square; that is, in rounding a curve the side frame on the inside of the curve would move ahead of the frame on the outside of the curve. Just how much was a matter of doubt, or I might say, a matter of calculation, rather than of actual measurement. The greatest amount that any one suggested was one and one-quarter inch. We were hardly prepared to find that it was nearly as much as three inches. We had expected to find that there might be ten to fifteen per cent. difference between the curve friction of loose and square trucks. We found as much as one hundred and fifty per cent. between the best square truck and the worst loose truck. We had anticipated that the load on the truck and its speed would regulate the amount the truck would go out of square, but it would seem from the tests made that the truck would go out of square approximately the same amount every trip around the curve regardless of its weight and speed. In fact, when it was merely pushed around the curve, slowly by hand, it would go out of square, the same amount as when it went around at high speed.

It was evident—as each truck tested went out of square an amount peculiar to itself—that there was something about its construction that acted as a stop to prevent further movement. Probably a wedging of the axle against the opening in the back end of the box and against the wedge and brass. It was noted in that type of arch bar truck in which the columns were riveted securely to the channel that the truck went out of square a less amount than those trucks in which the columns were bolted to the channel. This riveting of the column to the flanges of the channel made one less loose joint, and it may be that this one less loose joint introduced a stop at the columns or column bolts, which brought the truck to a bearing in advance of the stop furnished by the journal and box. There was also found an indication that the older a truck was in service, the more it would get out of square, this being no doubt due to a wearing away of the parts that stopped further movement of the truck, as well as a gradual loosening of the parts intended to hold the truck in square.

An interesting experiment was made to determine what effect the time of service would have upon those parts of an arch bar truck that are supposed to hold the truck square. A car was accidentally found in the yard that had been out from the contract show less than a month. It was a 50-ton truck of heavy construction, had cast steel truck columns bolted to a heavy channel, with two long bolts reaching through both columns. These bolts were tight, as were all bolts about the truck. The truck was put upon the testing plant and showed a very good test, one side frame moving ahead of the other only ¾ in., while a duplicate of this truck in service one year showed a movement of a trifle over 1¼ in., and a duplicate in service eight years showed almost 2-in. movement.

When trucks are new, all the surfaces bolted together being rough and the bolts tight, the friction between the parts will prevent all but a slight movement. It is this small initial movement of parts that brings about the final general looseness of the whole construction. The high points of the rough joint wear away, allowing the bolts to become loose, and then there is a still greater loosening of the parts in general by abrading, polishing or wearing away by friction. A bolted joint of this character is probably successful only when it is possible to so design it that all initial movement will be prevented. It only takes a small movement of the spring channel to give a considerable motion to the side frames, one ahead of the other. One-sixteenth of an inch motion of the channel under the spring seat will allow the side frame at the opposite side of the truck to move forward or backward about ¾ in. or ⅞ in.

That this initial movement exists in an arch bar truck, even when new, is not surprising when it is considered that the holes through the upturned flange of the spring channel for the horizontal column bolts are drilled 1/16 in. larger than the bolt; the holes in the arch bars are drilled 1/16 in. larger than the column bolts, and the hole through the column is cored usually ⅛ in. larger than the bolt passing through it, a possible 3/16 in. to 5/16 in. looseness to start with in the fit of the bolts. One does not have to look far to find reasons why the arch bar truck is a loose truck.

The fact that the arch bar truck does get out of square on a curve, the movement increasing with the age of the truck as indicated in the tests made by Professor Endsley, probably accounts for the trouble and expense for the upkeep of columns, column bolts, spring plank, bolts, etc. There is a continual motion and straining of parts at this point. It is impossible to keep the bolts tight, great trouble to keep them even in place, and it is quite natural that the repair account should be heavy if the joint is to be kept up, and it is quite natural, if the joint is not kept in proper repair, that the truck should fail to give the expected service results.

In reference to the connection between the spring channel and one-piece cast steel side frame, the tests demonstrated that a bolted connection was of little or no value as a means for making a tight immovable joint, that would hold the truck in square. The bolts were invariably found loose, and even after being tightened up thoroughly just before running a test, a very few runs would soon loosen up the joint. An extended examination of cars in service indicated that the bolt connection was of little value, as the bolts were nearly always found loose. On the other hand, an investigation covering a period of almost two years, and including several thousand cars, showed that the riveted joint was developing no signs of looseness, and was performing well the duty for which it was designed.

An occasional loose rivet was found, but one or even two loose rivets in a joint composed of a total of eight would indicate a looseness due to an imperfect application of the one or two rivets, rather than a looseness caused by service. The nature of the joint is such that road service could not loosen one or two rivets without loosening the whole joint. It was taken for granted that tight rivets presupposed a tight joint, and a tight joint meant a square truck. (It has been found, however, that tender trucks require more rivets than car trucks.) The Granite City tests confirmed the presumption that the riveted connection between the spring channel and side frame was a tight connection; which would remain tight in service and would hold the truck in square. Several of such trucks in service were tested and while the registering apparatus indicated a small movement it was not sufficient to influence the flange friction because the indicated movement was largely a changing in the perpendicular of the top of the side frame, due to the rigid connection between the two side frames being located some 12 in. to 15 in. below the top of the journal boxes, where the load is delivered to the axles. There was also a small amount of twisting of the side frame lengthwise along a line connecting the top of the two oil boxes on the same side of the truck, that was registered, as if it was a movement of the truck in and out of square. This same movement—in about double the amount—was also noted on the one or two arch bar trucks tested that were so new in service that they remained practically in square during the tests because the spring channel connection had not worked loose to any extent.

Professor Endsley's report shows that there is quite a material difference in curve friction in favor of a square truck, as against a loose truck. An amount of difference sufficient to affect the coal pile, life of rail, wheel maintenance and train resistance. Reducing the results obtained on the test track to a five and one-half degree curve brings out some interesting and somewhat startling information. A five and one-half degree curve is selected because it is possibly an average curve, and also because it makes a division by an equal divisor. The small fractions are left out in order to make round numbers. The drawbar pull in pounds per ton is found to be 9½ lbs. for the best square truck; 13.7 for the worst square truck; 11 lbs. for the best loose truck, and 17 lbs. for the worst loose truck. Broadly speaking, the difference between the square and the loose truck is due to a difference in truck construction.

The difference between the best and worst square truck is due almost entirely to wheel condition. In tabulating the re-

* See American Engineer, May, 1911, p. 192.

sults, as a matter of convenience, all trucks that went out of square one-half inch or less were classed as square trucks; so the difference in friction between a truck absolutely square and one out of square one-half inch should be deducted from the total difference between the best and the worst square truck—the balance is chargeable to wheel condition. However, the difference between a truck square and one out one half inch is a small amount. This fine line was not conclusively drawn in the tests, because of lack of time. The difference between the best and the worst loose truck is probably more evenly divided between that coming from truck construction and that resulting from wheel condition.

The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent—and as between the worst square and the worst loose, 24 per cent. in favor of the square truck. In both cases the difference may be said to be a difference in truck construction. As between the best and the worst square truck, the difference is 44 per cent., largely wheel condition. Between the best and the worst loose truck there is a difference of 54 per cent.; possibly somewhere near evenly divided between truck construction and wheel condition. The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent.—and as between the worst square and the worst loose 24 per cent. in favor of the square truck. In both cases the difference may be said to be difference in truck construction. Between the best and the worst square truck the difference is 44 per cent., largely wheel condition, and between the best and the worst loose truck there is a difference of 54 per cent., somewhere near evenly divided between truck construction and wheel condition. Between the best square truck and the worst loose truck is 79 per cent. The difference between the worst loose truck when run as a loose truck, and the same truck squared and run as a square truck was somewhere near 40 per cent. in favor of the truck squared, the difference being entirely due to truck construction.

The figures just given are from specific tests of specific trucks, and it probably hardly correct to undertake to construct a series of averages from them when it is considered that the averages used in calculating train resistance for actual service must of necessity represent the average resistance of all trucks, as they come in service. Therefore, it might be well to state that the average difference between all the square trucks and all the loose trucks tested was approximately 24 per cent. in favor of the square truck, based on a five and one-half degree curve. An average is the mean between two extremes. If the maximum and the minimum are near and close to the average, there is small chance to close up the gap between the average and the maximum in an attempt to reduce the average. But, if the maximum, and the minimum are comparatively widely separated, and the units in between are valuable, there is a greater chance to reduce the average and an effort is worth while. It is probable that little is known of the actual maximum and minimum that make up the average train resistance as used in every-day practice.

It would seem that some information has been developed along this line by the test made last summer, and the figures quoted above are possibly most interesting from this point of view. The tests show there is a difference of almost 80 per cent. between the maximum and minimum, due to both truck construction and wheel conditions and approximately 40 per cent. due to truck construction alone. A difference certainly—sufficiently material—to justify an elaborate and serious investigation by the railroads.

Several railroad men who visited the plant during the tests were forcibly struck with the idea that it was possible car wheels were allowed to run too long, and it might be better economy to remove them sooner. When the theory and reasons are known, it is not surprising that the curve friction of a loose truck should be greater than a square truck. Some very interesting experiments were made by whitewashing the rails on the curve, and noting the difference in contact between the wheel and the rail with the truck square and loose. When a truck was run square, there was only one point of contact between the wheel and the rail. This was on the ball of rail and in the deep part of the throat of the flange of the wheel. When the truck was run loose, there were two distinct points of contact, one on top of the rail and one on the side of the rail, there being from ⅛ in. to ⅜ in. between these two lines, depending upon how much the truck went out of square. In this case the whitewash was left on the ball of the rail, and the throat of the wheel did not show any contact with the ball of the rail. When the truck was stopped on the whitewash and run back, the end of the mark on the side of the rail made by the flange was from 1 in. to 2½ in. in advance of the end of the mark on top of the rail, made by the tread of the wheel. It could be seen, when the truck was in this position, by sighting along the edge of the rail, that there was no contact between the throat of the flange and the ball of the rail.

When the square truck was rounding the curve, the throat of the wheel being in contact with the ball of the rail, and the axles square with the track, the outside wheel would climb up on the rail, enlarge itself an amount sufficient to make up for the difference in the length of the inside and outside rails, and the wheels would go around the curve without slipping—the friction being all rolling friction. But, when the truck was running as a loose truck and got out of square, the throat was not in contact with the ball of the rail, and the flange being in contact with the side of the rail, acted as a shoulder so that the wheel could not move over on to the throat and climb the rail, therefore either the outside or the inside wheel had to slip the difference between the length of the two rails.

When the truck is running square, the friction between the wheel and rail is rolling friction, but when the truck is running loose and gets out of square, there is just as much rolling friction as there was before and in addition there is sliding friction between the flange and the side of the rail, which must be considerable, and the slipping or sliding of the tread of the wheel, on the top of the rail—because of the difference in the length of rails, and the inability of the outside wheel to enlarge itself, owing to lack of throat contact with the ball of the rail. This was plainly noticeable by listening to the noise the truck made in going around the curve. When the truck was square it made just a single rumbling noise, quite natural to a vehicle of this kind, but when running loose, in addition to the ordinary rumbling noise could be heard a loud flange song, and a distinct high sounding and piercing noise caused by the tread slipping on top of the rail. The latter noise was not a continuous one, but intermittent in very short intervals. The flange song was a continuous noise.

On a five and one-half degree curve, in the distance a 33-in. wheel makes in one revolution, the outside rail is about ½ in. longer than the inside rail, and with a loose truck this means that either the outside or the inside wheels must slip this one-half inch every revolution, and if the outside wheels do the slipping they not only have to overcome the friction between the tread and top of rail, but also the friction between the flange and side of rail. It is possible that the inside wheel does most of the slipping.

There is also one other source of increased friction in the loose truck, which is sliding friction. When a truck is running out of square, the axles are not square with the track, therefore the wheels are not revolving in a plane parallel with the direction of the rails, and if it were not for the flanges, the tendency of the wheels would be to run to the right, or the left, as the case might be. The natural track for the wheels to make would be one diverging from the rails, and they would only track in a line with the rails by a certain amount of slipping. This point can be better illustrated perhaps by presuming the front wheels of a wagon turned the necessary amount to go around a street corner, and then locked in this position. One can readily see it would require an extra effort on the part of the horses to pull the wagon, with the front wheels so turned and locked, in a straight line. The front wheels would revolve, but much slower than the rear wheels, and they would also slip along the pavement.

It must be this slipping that causes the increased friction in loose trucks going out of square from nothing up to one inch, and before the flange begins to make a contact with the side of the rail. It will be noticed from Professor Endsley's report, that there is a big jump in the friction between an inch, and an inch and one-half out of square. It is thought that the increase in friction up to one inch out of square is caused by the gradual increase in the slipping action just noted above, and that along about this point is where the flange begins to make the sliding contact against the side of the rail. Of course, it might be said that these tests, as they deal almost entirely with curve friction, do not interest the road that has almost all of its mileage straight track. This would be taking a somewhat narrow view of the matter. Owing to the great exchange or interchange of cars between the different railroads, it is possible the man on a road full of curves would be very much interested in the kind of a truck his straight track neighbor puts under his cars.

The tests were made for the sole purpose of determining, if possible, the facts regarding the difference between trucks that run square and those that run loose, as there seems to be a great difference of honest opinion among rilroad men, regarding the merits of each type of truck with apparently no convincing data at hand on which a final judgment could be based. The tests were made in the only manner in which it was possible to make them, considering the particular facts it was desired to determine. The results of the tests and experiments were given out because, first, they are tests that have never before been made so far as is known, and second, the data secured were considered of such value and importance that they would be at least passively appreciated by the railroad official who is interested in the economics of railway operation, and, third, because the majority of railroad men who knew the tests were being made requested that they be furnished with full results.

It is not the idea that these tests are final, nor that they rep-

resent absolutely service conditions. They were given out merely for what they are worth, and in so far as they go. They are considered as a preliminary to a more serious test that it is hoped will be made by the railroads themselves. It is felt, however, that the tests are a close approximate to what will be found in actual service, and are of sufficient value to be entitled to full consideration, pending more elaborate dynamometer tests in actual service.

HEAVY SWITCHING LOCOMOTIVE

CHICAGO & WESTERN INDIANA RY.

The heavy character of the switching requirements on the Chicago & Western Indiana Ry. has brought about a remarkable development in locomotives intended exclusively for this service. A prominent example of this increase in size, weight and power may be found in the engine herewith illustrated, which is one of ten recently built for this road by the Lima Locomotive and Machine Co. of Lima, O. While not embodying any particular departures in constructive details these locomoives are noteworthy for their total weight of 201,000 lbs., or approximately 50,000 lbs. per axle, and for the comparatively large diameter of driving wheels employed, which is 57 inches.

NEW SWITCHING LOCOMOTIVES FOR CHICAGO BELT LINE.

The tractive effort is 43,290 lbs., providing ample power for the service.

The latter on the Belt Line imposes some rather peculiar conditions which must be met in switch engine design, and prominent among these is the fact that in addition to the requisite of a locomotive of great power it must necessarily be one capable of more than the average speed for this type of locomotive. This, of course, is demanded by the congestion on the Belt Line arising from the presence of so many passenger trains of the various roads which use it. Switching operations must therefore be conducted expeditiously in order that no interference may exist with the above mentioned important traffic.

Since being placed in service these locomotives have been giving excellent satisfaction, and the railroad company is well pleased with the first-class material and workmanship embodied in their construction. The builders made quite a record with this contract, which is deserving of mention. The order was given by the railroad company on November 7, 1910, and shipment was stipulated at the rate of five locomotives during the month of February, 1911, and five during the month of March. The last of the ten engines left the Lima Works on March 30, on exact time agreed upon.

The following are the principal dimensions of these locomotives:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Switching
Fuel	Bit. Coal
Tractive power	43,290 lbs.
Weight in working order	201,000 lbs.
Weight on drivers	201,000 lbs.
Weight of engine and tender in working order	342,500 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, engine and tender	51 ft. 4 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.64
Tractive effort × diam. drivers ÷ heating surface	823
Total heating surface ÷ grate area	72.7
Firebox heating surface ÷ total heating surface, %	5.5
Weight on drivers ÷ total heating surface	67.4
Volume both cylinders	14.62 cu. ft.
Total heating surface ÷ vol. cylinders	205
Grate area ÷ vol. cylinders	2.81
CYLINDERS.	
Kind	Simple
Diameter and stroke	24 x 28 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving journals, main, diameter and length	10 x 13 in.
Driving journals, others, diameter and length	9½ x 13 in.
BOILER.	
Style	E. W. T.
Working pressure	180 lbs.
Outside diameter of first ring	74⅜ in.
Firebox, length and width	108 1/16 x 60¼ in.
Tubes, number and outside diameter	327—2¼ in.
Tubes, length	14 ft. 9—9/16
Heating surface, tubes	2,832.14 sq. ft.
Heating surface, firebox	165.95 sq. ft.
Heating surface, total	2,998.09 sq. ft.
Grate area	41.2 sq. ft.
TENDER.	
Water capacity	7,400 gals.
Coal capacity	11 tons

FRESNEL LENS IN RAILROAD SERVICE

The problem of getting a light that would carry around curves is one on which the railroads have been working for years, because it means so much to them from the standpoint of safety. The Fresnel lens has been worked on by numerous railroads, but there were mechanical problems connected with it they were unable to overcome. B. H. Mann, chief signal engineer of the Missouri Pacific-Iron Mountain, has been working for over a year to overcome these defects and has finally succeeded in perfecting the lamp so that it can be used on railroad trains.

Service tests have been made recently on the Hot Springs Special and on both of the through fast trains to Texas. These tests have been most satisfactory, and arrangements are now being made to have the Fresnel lens signal lamp to take the place of all other signal lamps on all trains of the system. The big advantage of the wide spread of light that the Fresnel lens gives is that in rounding a curve it spreads its rays in all directions over the land, so that trains on the other turn of the curve can plainly see it, whereas they cannot observe the light of the ordinary train signal lamp. This fact gives the Fresnel lens a great advantage in the line of safety.

PUNCTUALITY OF THE 18-HOUR SERVICE.—Since the service was inaugurated the Pennsylvania Railroad's eighteen-hour trains between New York and Chicago have made enviable records according to figures made public by the company recently. The Chicago-New York flier, No. 28, has a shade the better on the general punctuality average, but No. 29 evens things when it comes to clean monthly records. In three months it was not late a minute, and there were nine months in which it was not late more than once in each month. No. 28's best record was made during five months, in each of which it was not late more than twice. It is pointed out that in the majority of cases when these trains were late the detention was only from five to fifteen minutes.

IN HIGH SPEED STEELS, that steel containing 0.25 per cent. Vanadium has a cutting capacity almost double that of steel containing no Vanadium.

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The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent—and as between the worst square and the worst loose, 24 per cent. in favor of the square truck. In both cases the difference may be said to be a difference in truck construction. As between the best and the worst square truck, the difference is 44 per cent., largely wheel condition. Between the best and the worst loose truck there is a difference of 54 per cent.; possibly somewhere near evenly divided between truck construction and wheel condition. The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent.—and as between the worst square and the worst loose 24 per cent. in favor of the square truck. In both cases the difference may be said to be difference in truck construction. Between the best and the worst square truck the difference is 44 per cent., largely wheel condition, and between the best and the worst loose truck there is a difference of 54 per cent., somewhere near evenly divided between truck construction and wheel condition. Between the best square truck and the worst loose truck is 70 per cent. The difference between the worst loose truck when run as a loose truck, and the same truck squared and run as a square truck was somewhere near 40 per cent. in favor of the truck squared, the difference being entirely due to truck construction.

The figures just given are from specific tests of specific trucks, and it probably hardly correct to undertake to construct a series of averages from them when it is considered that the averages used in calculating train resistance for actual service must of necessity represent the average resistance of all trucks, as they come in service. Therefore, it might be well to state that the average difference between all the square trucks and all the loose trucks tested was approximately 24 per cent. in favor of the square truck, based on a five and one-half degree curve. An average is the mean between two extremes. If the maximum and the minimum are near and close to the average, there is small chance to close up the gap between the average and the maximum in an attempt to reduce the average. But, if the maximum, and the minimum are comparatively widely separated, and the units in between are valuable, there is a greater chance to reduce the average and an effort is worth while. It is probable that little is known of the actual maximum and minimum that make up the average train resistance as used in every-day practice.

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Several railroad men who visited the plant during the tests were forcibly struck with the idea that it was possible car wheels were allowed to run too long, and it might be better economy to remove them sooner. When the theory and reasons are known, it is not surprising that the curve friction of a loose truck should be greater than a square truck. Some very interesting experiments were made by whitewashing the rails on the curve, and noting the difference in contact between the wheel and the rail with the truck square and loose. When a truck was run square, there was only one point of contact between the wheel and the rail. This was on the ball of rail and in the deep part of the throat of the flange of the wheel. When the truck was run loose, there were two distinct points of contact, one on top of the rail and one on the side of the rail, there being from ⅛ in. to ⅝ in. between these two lines, depending upon how much the truck went out of square. In this case the whitewash was left on the ball of the rail, and the throat of the wheel did not show any contact with the ball of the rail. When the truck was stopped on the whitewash and run back, the end of the mark on the side of the rail made by the flange was from 1 in. to 2½ in. in advance of the end of the mark on top of the rail, made by the tread of the wheel. It could be seen, when the truck was in this position, by sighting along the edge of the rail, that there was no contact between the throat of the flange and the ball of the rail.

When the square truck was rounding the curve, the throat of the wheel being in contact with the ball of the rail, and the axles square with the track, the outside wheel would climb up on the rail, enlarge itself an amount sufficient to make up for the difference in the length of the inside and outside rails, and the wheels would go around the curve without slipping—the friction being all rolling friction. But, when the truck was running as a loose truck and got out of square, the throat was not in contact with the ball of the rail, and the flange being in contact with the side of the rail, acted as a shoulder so that the wheel could not move over on to the throat and climb the rail, therefore either the outside or the inside wheel had to slip the difference between the length of the two rails.

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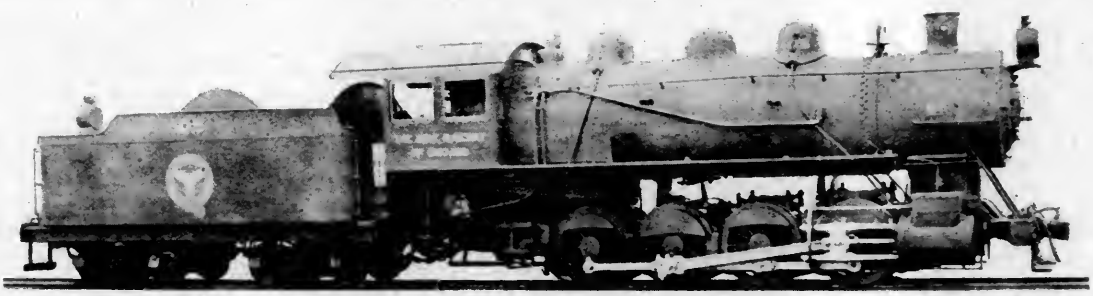

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FRESNEL LENS IN RAILROAD SERVICE

The problem of getting a light that would carry around curves is one on which the railroads have been working for years, because it means so much to them from the standpoint of safety. The Fresnel lens has been worked on by numerous railroads, but there were mechanical problems connected with it they were unable to overcome. B. H. Mann, chief signal engineer of the Missouri Pacific-Iron Mountain, has been working for over a year to overcome these defects and has finally succeeded in perfecting the lamp so that it can be used on railroad trains.

Service tests have been made recently on the Hot Springs Special and on both of the through fast trains to Texas. These tests have been most satisfactory, and arrangements are now being made to have the Fresnel lens signal lamp to take the place of all other signal lamps on all trains of the system. The big advantage of the wide spread of light that the Fresnel lens gives is that in rounding a curve it spreads its rays in all directions over the land, so that trains on the other turn of the curve can plainly see it, whereas they cannot observe the light of the ordinary train signal lamp. This fact gives the Fresnel lens a great advantage in the line of safety.

Punctuality of the 18-Hour Service.—Since the service was inaugurated the Pennsylvania Railroad's eighteen-hour trains between New York and Chicago have made enviable records according to figures made public by the company recently. The Chicago-New York flier, No. 28, has a shade the better on the general punctuality average, but No. 29 evens things when it comes to clean monthly records. In three months it was not late a minute, and there were nine months in which it was not late more than once in each month. No. 28's best record was made during five months, in each of which it was not late more than twice. It is pointed out that in the majority of cases when these trains were late the detention was only from five to fifteen minutes.

In High Speed Steels, that steel containing 0.25 per cent. Vanadium has a cutting capacity almost double that of steel containing no Vanadium.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Nov. 14	Lighting	J. A. Shaw.	Jas. Powell	Room 13, Windsor Hotel, Montreal.
Central	Nov. 10	The Distribution of Instructions and Information in Large Industries.	F. M. Whyte.	H. D. Vought	95 Liberty St., New York.
New England	Nov. 14			Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Nov. 17	Tool Steel.	W. B. Sullivan.	H. D. Vought.	95 Liberty St., New York.
Northern	Nov. 28	Engine Failures.	G. Osguard.	C. W. Alliman	P. & L. E. R. R., Gen.. Office, Pittsburgh, Pa.
Pittsburg	Nov. 24	Swedish Steel *vs.* Others.	A. R. Roy.	F. O. Robinson	C. & O. Ry., Richmond, Va.
Richmond	Nov. 10	Election of Officers.		A. J. Merrill	218 Grant Bldg., Atlanta, Ga.
S'th'n & S. W'st'n	Nov. 16	Steel and Steel Castings.		Jos. W. Taylor	390 Old Colony Bldg., Chicago.
Western	Nov. 21			W. H. Rosevear	100 Chestnut St., Winnipeg, Man.
Western Canada	Nov. 13				

CONSERVATION OF WASTE.

CENTRAL RAILWAY CLUB.

The various factors bearing on the above timely subject were well presented in a paper read by J. F. Murphy, general storekeeper of the Lake Shore & Michigan Southern Ry., before the September meeting of this club. The author prefaced his paper by calling particular attention to the importance of the scrap dock, as from it may be obtained, through careful study, the history and record of materials, the abuses to which material is put, and the disregard for its value, as shown by material thrown into scrap which has never seen service. This portion of the paper was accorded a lively discussion and opinion was divided on the question of assorting and reclaiming stock before or after it reaches the scrap dock. Mr. Sitterly, chief inspector of the Pennsylvania Railroad, advised against the former practice on the ground that as laborers pick up scrap material it is better to allow all such to go to the dock and be sorted by competent men.

Mr. Murphy's paper practically outlined the methods in vogue for the conservation of waste on the Lake Shore and advocated that they were of general application. In considerable detail he pointed out the very great saving which can be made in the re-working or conversion of scrap material into other and useful forms. The questions of manufacturing, ordering, caring for, and disbursing of material were also briefly touched upon. This paper was of particular value in view of the discussion which it awakened, and while in connection with some of the items a difference of opinion was expressed with the author, the points brought out were of great interest to all present.

GERMAN WATERWAYS.

NEW YORK RAILWAY CLUB.

One of the most interesting papers ever read before this club was presented by Professor Edwin J. Clapp, of New York University, on the above subject at the meeting September 15, 1911. The author showed great familiarity with the general conditions appertaining to the waterways of Germany, and the paper afforded a vast fund of statistical information, many items of which have been hitherto unpublished. The unfamiliarity of the members with the subject unfortunately prevented a very extensive discussion, although the paper was listened to attentively and Professor Clapp was heartily congratulated on the elaborate research embodied in its preparation. It was pointed out that the Rhine and the Elbe are the most efficient waterways in Europe and most worthy of our attention. They exhibit a high degree of modernization in the floating stock operating on them, in the river harbors which collect and distribute their freight, and in the co-operation which exists between river and railroad. So effective is the form of water transportation described that the Elbe carries four-fifths of Hamburg's trade with that part of the interior which is reached by both waterways and railways. Commenting on the possibility of the Mississippi system ever seeing such a river traffic as the Rhine and Elbe enjoy, Professor Clapp pronounced it an interesting question for speculation, but with few signs at present of such a development. It will be rash to predict when the Mississippi will have a similar moderniation of its transportation, and a similar diversity of traffic, and the author believes that it would be less rash to assert that, if and when this modernization does come, it will best be along the lines developed by the Germans on their two great streams.

THE STREET DEPARTMENT AND SUGGESTIONS FOR TEAM TRACK DRIVEWAYS.

ST. LOUIS RAILWAY CLUB.

The opening meeting of the above club for the season of 1911-1912 was called to order by President Pfeifer at 8 P. M. on Friday, September 8, a large attendance being present. The paper of the evening was presented by Hon. J. C. Travilla, street commissioner of St. Louis, and was appreciatively received by the members. Street pavements and good roads are viewed with more interest by the railroads at the present time than ever before. The operating department is directly interested in well paved and maintained streets, as such advantages mean the handling of freight without congestion at terminals twelve months of the year. In fact, the railway companies are sending out special trains carrying experts with road machinery and equipment for the sole purpose of educating the people to build good roads, and in so doing they are the direct beneficiaries. More than one hundred lantern slides were shown illustrating city planning, street paving, with special reference to its use for team track driveways; the cleaning and maintenance of pavements, and the construction of roads.

SOME EXPERIMENTS WITH TRUCKS.

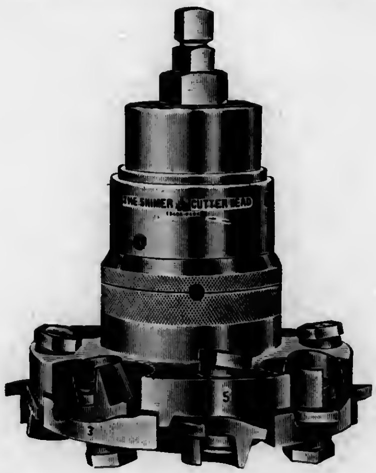
WESTERN RAILWAY CLUB.

The September meeting of this club was favored by an extremely valuable paper on the above subject by George G. Floyd, which has been liberally abstracted on page 455 of this issue. Without a doubt the tests referred to were the most elaborate ever undertaken to secure positive data on the subject of square versus loose car trucks in this or any other country, and the conclusions and deductions are of more than passing importance. These experiments were the outgrowth of a decision reached by the American Steel Foundries, in view of the evident poverty of information on the subject, to build a piece of full size track, install all scientific apparatus necessary, and determine beyond doubt, if the square truck was the better construction and how much, or to what degree it was better. Professor Endsley, of Purdue, superintended the testing plant and tests, the latter extending over a period of nearly four months during the summer of 1910. Following the reading of the paper, the discussion developed that the subject had received consideration by a number of roads, and considerable data had been gathered individually, but with no attempt at compilation. In view of the great interest exhiited by the members in the paper the motion was seconded and carried unanimously that the discussion be continued to the next meeting.

AN IMPROVED CUTTER HEAD

In the design of the new "Shimer Limited" cutter head, recently put on the market by Samuel J. Shimer & Sons, Milton, Pa., the special points or requirements imposed on these tools in modern practice were given most careful consideration, and a study of the latest type shows conclusively that the device is in every way designed to cope with them. To match flooring at the rate of 150 to 170 lineal feet per minute requires side heads of special construction. They must have great strength to stand the enormous centrifugal strains and must have a perfect balance, and the bits must all do their share of the cutting.

The new head differs from the familiar patterns in the method of attaching them to the spindles in the construction of the bit seats, and of the bit designed for faster cutting; in the greater strength of the holding bolts, and especially in the self-centering device which clings to the spindle when drawn up and secures it firmly thereto.



The spindle gripping device is positive and effective in its purpose of holding fast to the spindle and also in centering the head for a more uniform action of the cutters. This is accomplished by having the central bore of the head tapered and having a rotatable cap and nut fitted in the upper portion. Into this bore a taper collet projects, having an upper threaded portion fitted to the rotatable nut. When the top nut is drawn up the collet contracts and binds itself firmly to he spindle. This arrangement is simple and effective and one not likely to get out of order. The various parts are made of good steel forgings and the collets are hardened and ground true to size. The entire construction of the tool is exceptionally fine in both workmanship and material.

The bit seats in these new heads carry a larger surface, and the bit chambers are of greater depth, to compensate for the new acute angle given the bits for greater relief to the parts coming in contact with the lumber. The holding bolts have been strengthened several times over by the use of a high grade steel especially made for the purpose.

TEXAS LINES USING OIL FOR FUEL.—Crude petroleum has displaced coal as fuel for locomotives upon nearly all the Texas railroads. The announcement has just been made that the Texas and Pacific will soon convert all of its locomotives into oil burners. The St. Louis Southwestern, another Gould line, will also use oil for fuel upon its Texas and Arkansas divisions, it is stated. These two roads will obtain their oil supply from the Caddo field in Louisiana. The Southern Pacific has been using oil for its locomotives since shortly after the discovery of the product at Spindle Top, Tex., about ten years ago. It now uses this fuel on all of its Texas lines, as well as on its main line between New Orleans and San Francisco. The oil supply for its eastern divisions is obtained from the California fields.

PERSONALS

GEORGE STONE has been made general foreman of the Chicago, Rock Island & Pacific Ry. at Shawnee, Okla.

H. B. MCDOWELL has resigned as roundhouse foreman of the Chicago and Indiana Southern Ry. at Gibson, Ind.

W. H. SHOLL has been appointed roundhouse foreman at Dunmore, Pa., Erie Railroad, vice E. L. Briggs, deceased.

A. G. KANTMANN was on Oct. 9 appointed acting superintendent of machinery of the Nashville, Chattanooga and St. Louis Ry.

A. B. TODD has been apointed master mechanic of the Butte County R. R., succeeding James Chambers, with office at Chico, Cal.

JAMES SHEA has been promoted to be night roundhouse foreman at Bergen, N. J., Erie Railroad, succeeding John Fuller, transferred.

C. A. GERARD has been made storekeeper of the Santa Fe at Dodge City, Kan., vice O. E. Cochran, transferred to Arkansas City, Kans.

FRANK A. DE WOLF has been appointed acting shop superintendent of the United Railways of Havana, with headquarters at Havana, Cuba.

H. Y. HARRIS, general foreman of the Tampa Northern R. R., has been appointed master mechanic, his headquarters remaining at Tampa, Fla.

P. M. HAMMETT has been appointed superintendent of motive power of the Sandy River and Rangely Lakes R. R., with office at Portland, Me.

GEORGE C. SMITH has been appointed purchasing agent of the Union Pacific Ry., with office at Omaha, Neb., succeeding J. W. Griffith, retired.

W. R. RYAN, general car foreman of the Baltimore and Ohio R. R. at Pittsburg, Pa., has resigned to accept service with the Union R. R. in a similar capacity.

JAS. B. HARTIGAN, who was appointed federal boiler inspector for District No. 1 at Rutland, Vt., has declined the appointment and will remain with the Rutland Ry.

R. T. WILLIAMS has been appointed superintendent of shops at Beach Grove on the Cleveland, Cincinnati, Chicago & St. Louis Ry., succeeding M. J. McCarthy, promoted.

JOHN FULLER, night roundhouse foreman at Bergen, N. J., on the Erie Railroad, has beeen transferred to night roundhouse foreman at Jersey City, N. J., vice W. H. Sholl, transferred.

J. F. DEEMS, General Superintendent of Motive Power, Rolling Stock and Machinery of New York Central Lines has resigned to become President of the Ward Equipment Company, 139 Cedar Street, New York City.

T. F. POWERS, master boilermaker of the Chicago and North Western Ry. at Chadron, Neb., has been made general boiler shop foreman of the system, vice J. W. Kelly, resigned to accept service with the National Tube Co.

M. J. FAHY, general foreman of the New York, New Haven & Hartford R. R. at New Haven, Conn., has been transferred to the company's Readville, Mass., shop, exchanging positions with John Reid, who goes thence to the New Haven shop

D. T. WILLIAMS, mechanical engineer of the Philadelphia & Reading Ry., will report direct to H. D. Taylor, superintendent of motive power and rolling equipment, at Reading, Pa., and the position of superintendent of power house at the Reading terminal has been abolished.

F. C. PICKARD, master mechanic of the Cincinnati, Hamilton and Dayton Railway at Indianapolis, Ind., has resigned to take a similar position with the Pere Marquette Railway, with office at Saginaw, Mich. Mr. Pickard is well known as president of the International Railway General Foremen's Association.

M. J. MCCARTHY, superintendent of shops of the Cleveland, Cincinnati, Chicago & St. Louis R. R., the Peoria & Eastern Ry. and the Cincinnati Northern Ry., at Beech Grove, Ind., has been appointed assistant superintendent of motive power, with headquarters at Beech Grove.

G. A. HICKOK has been appointed purchasing agent of the Missouri, Kansas & Texas, with office at St. Louis, Mo., succeeding A. I. Miller, deceased.

J. F. PRENDERGAST, formerly for ten years master mechanic at the Baltimore & Ohio shops at Pittsburgh, Pa., has been appointed master mechanic of the East Broad Top Railroad & Coal Co., also of the Rockhill Iron & Coal Co., with office at Orbisonia, Pa.

CATALOGS

PUMPS AND CONDENSERS.—The Dean Bros. Steam Pump Works, of Indianapolis, Ind., has issued an interesting "pony" catalog, No. 86, which illustrates a few of the standard styles and sizes of pumps and condensers. The book contains 64 pages and presents very attractively the Dean Bros. products.

ROLLER BEARING CAR JOURNALS.—The Standard Roller Bearing Co., of Philadelphia, Pa., has prepared in Bulletin 26 some exceedingly interesting information and valuable data on this important subject. The catalog is very handsomely illustrated with half tones and sectional drawings to scale of the standard roller bearings.

HEAT TREATED AXLES, ETC.—The Carnegie Steel Co. of Pittsburg, Pa., has recently issued a very valuable descriptive booklet on the above general subject which will be much appreciated by those interested in this process. The latter is fully described and the tables and charts showing average results of experimental tests are of exceptional value.

VERTICAL BORING AND TURNING MILLS.—A very interesting leaflet has recently been issued by the Gisholt Machine Company, of Madison, Wis., illustrating views of two representative shops of Continental Europe which are making the most of the labor-saving features that have caused the Gisholt mills to be accepted by keen production experts everywhere.

LATHES.—Under this general title the R. K. Le Blond Machine Tool Co., of Cincinnati, O., has recently put out an elaborate catalog of some 150 pages dealing with the extensive line of lathes included in its output. The latter, which are fully illustrated and described, are new throughout and have been designed to meet the ever increasing demands of modern shop practice. The catalog is of especial value in its description of heavy duty lathes in which all points of construction and assemblage are minutely analyzed.

NEW TYPE PASSENGER LOCOMOTIVE.—Bulletin No. 1011 from the American Locomotive Company describes the new "Mountain" type passenger locomotive (4-8-2) recently placed in service on the heavy grade division of the Chesapeake & Ohio Railway. This locomotive was fully described and illustrated in the October issue of the AMERICAN ENGINEER AND RAILROAD JOURNAL. Its total weight exceeds any locomotive of rigid frame construction, being 239,000 on four axles, which gives an average weight per axle of nearly 60,000 lbs.

HORIZONTAL MILLING MACHINES.—The Fosdick Machine Tool Co., of Cincinnati, O., has a descriptive leaflet of its No. 0 horizontal boring, drilling and milling machine which enumerates the interesting features of design and construction, including also the complete specifications. In the design of this machine several prominent points of advantage will be found, including the deep bed of great rigidity, which makes the machine self-contained and a foundation unnecessary, and also insuring perfect alignment of the table with the spindle and outer support at all times.

ROTARY CONVERTERS.—Descriptive Leaflet 2378, covering rotary converters for railway service, has just been issued by the Westinghouse Electric and Manufacturing Company. This is a four page leaflet, nine and a half by eleven inches, and contains quite a number of illustrations describing the various parts of rotary converters, such as armature coils, spider, equalizer connections, collector rings, commutator brush riggings, etc. Under each picture is given a short description of the method of construction of the part illustrated. One page is devoted to pictures of the rotary converters completely assembled.

PIPE THREADING DIES.—In Bulletin No. 6 the National Tube Co., Pittsburgh, Pa., has compiled proper information on the subect of threading pipe which will well repay perusal. The subject is of very general interest, and although the bulletin is short, it represents some years of experience and a great many experiments. The intent is to show that there is a great deal of misinformation abroad on the question and that in many instances badly constructed dies are used which tear the pipe, and the blame is erroneously placed on the latter.

AIR COMPRESSORS.—The Ingersoll-Rand Co., 11 Broadway, New York City, has issued Bulletin No. 3007, of 24 pages, descriptive of class "B. B." power driven air compressor, duplex type, with the air cylinders close coupled to the frame and a central driving wheel. The catalog shows several views of the machine in section, and gives tables of sizes and capacities. The distinctive features of this "PB" design are its massive, powerful construction and its simplicity, rugged strength, ample reserve power and unlimited capacity for hard work. The machine is readily accessible, inside and out, and is provided with flood lubrication system. Automatic control of the pressure and regulation of output to load are provided by governing devices.

NEW YORK LEATHER BELTING CO.—On May 1 the new plant at Easton, Pa., was opened for active operations for the manufacture in America of Victor-Balata belting. For a number of years this belting has been manufactured in Germany and imported into America by the New York Leather Belting Company. While this was satisfactory as far as obtaining the great quality feature of the belting which rapidly put it in the lead of the Balata belting group, and at the head of the textile belting class, there were delays due to importation of the same and attendant duty costs, etc., and it was finally decided to erect a plant in this country. The new company is composed of German and American interests who have been connected in a business way in the Balata belting line for a number of years. The German members of the company are those of the well-known belting manufacturers, C. Vollrath & Sohn, of Blankenburgh, Germany, and C. E. Aaron and J. R. Stine, of New York, Mr. Aaron being the President of and Mr. Stine the Secretary-Treasurer of the New York Leather Belting Co., New York. The officers of the new company are as follows:—C. E. Aaron, President; J. R. Stine, Treasurer, and Edwin Vollrath, Secretary, and manager of the new plant at Easton.

NOTES

ALLIS-CHALMERS CO.—David Van Alstyne, vice-president, has resigned and will locate in New York City.

WOODHOUSE CHAIN WORKS.—Wood & Van Nest have been appointed to represent the above firm in New York City, with office at 26 Cortlandt St.

HANNA LOCOMOTIVE STOKER CO.—The offices of this company, Cincinnati, O., have been removed from the Second National Bank building to the Mercantile Library building.

CORRUGATED BAR CO.—The general offices of this company have been moved from the New National Bank of Commerce Building, St. Louis, Mo., to the Mutual Life Building, Buffalo, N. Y.

BEST MANUFACTURING CO.—This company has recently moved its entire factory into a new plant which has been completed at Oakmont, Pa., and is said to be the most modern manufacturing plant in the United States.

DETROIT TWIST DRILL CO.—Halsted Little, for many years associated with the sale department of Manning, Maxwell & Moore, has been appointed Eastern Sales Agent for the Detroit Twist Drill Company, with offices at 30 Church Street, Room 604.

T. H. SYMINGTON CO.—Announcement is made of the resignation of vice-president W. A. Garrett, who re-enters railroad service. Mr. Garrett was chief executive officer of the Seaboard Air Line prior to November, 1909, when he left to go to the T. H. Symington Co.

WESTINGHOUSE AIR BRAKE CO.—C. J. Nash, who has been connected with this company for the past year as special representative in the draft gear department, has resigned to engage in the railway supply business, where he will make a specialty of draft gear attachments.

BROWN HOISTING MACHINERY CO.—This company of Cleveland, O., announces the opening of its San Francisco office, Monadnock Bldg., with J. P. Chase as manager, and of its Chicago office in the Commercial National Bank Bldg., with A. M. Merryweather as manager.

ROBERTS & SCHAEFER CO.—This company of engineers and contractors, Chicago, Ill., has just been awarded a contract by W. J. Backes, chief engineer of the Central New England Ry., which is one of the affiliated lines of the N. Y., N. H. & H.R.R. ,for the design and construction of a 600 ton locomotive coaling station for installation at Maybrook, N. Y. Contract price approximately $13,000.

A. EUGENE MICHEL.—The main offices of A. Eugene Michel and staff, advertising engineers, have been moved into the Park Row Buildng, 21 Park Row, New York, where larger space has been secured, as necessitated by constantly increasing business. Temporarily the photo re-touching and illustrating department will remain in the Hudson Terminal Buildings, but all business will be managed from the new offices.

WOOD LOCOMOTIVE FIREBOX CO.—A report supplementary to that published in the October number of the AMERICAN ENGINEER AND RAILROAD JOURNAL on the condition of engine 2481 of the New York Central, which is equipped with the Wood boiler, shows that only two staybolts required removal. This examination covered the period from October, 1910, and these were the only bolts affected in that time. The record must be considered as remarkable in view of the heavy freight service in which the locomotive has been steadily engaged.

J. G. WHITE CO.—Gano Dunn who for many years was First Vice-President and Chief Engineer of the Crocker-Wheeler Company, and is a past President of the New York Electrical Society, has been elected a Director and a Vice-President of J. G. White & Company, Inc., of New York, N. Y. Mr. Dunn has just returned from abroad, where, as a representative of the United States Government, and as President of the American Institute of Electrical Engineers, he has been attending the International Electrical Congress at Turin and the meeting of the International Electro-Technical Commission, the body that has been organized to bring about international uniformity of standards and practice in the electrical industry.

Service of Mallet Articulated Locomotives

DETAILED REPORT OF WHAT LOCOMOTIVES OF THIS COMPARATIVELY NEW TYPE ARE DOING IN ACTUAL ROAD SERVICE AND A STUDY OF THEIR ACTUAL MONEY VALUE UNDER CERTAIN CONDITIONS WHEN COMPARED WITH THE CONSOLIDATION TYPE.

In determining the actual value of any particular type of locomotive, it is necessary to take into consideration four features: 1. What are the net returns in dollars and cents of its service on the road as compared with the type previously in use? 2. Compared with this same type, what is its cost, all things being considered, while at the roundhouse, not ready for service? 3. What is the yearly cost per ton-mile, or on other similar basis for general repairs that take it out of service completely for a considerable length of time? 4. Does the net balance of saving from these three features when compared with the previous type in use equal the interest on its increased original cost?

Of course, to come to an accurate result in a study of this kind, it is necessary to have the detailed figures covering several years' service, and in the case of the Mallet, with but few exceptions, these are not available. From previous experience and data already collected from other new types, it is, however, quite possible, even after a comparatively short service, to arrive at a fairly accurate conclusion of what the net result is going to be. Also, in the case of the Mallets in particular, it is necessary to consider the fact that the design has been in the process of development, and that there has been and still continues to be an improvement in practically each new order sent out. This, then, places a study of the locomotives already in service well on the safe side, if the final conclusions are favorable.

There are at present about 500 locomotives of the Mallet type in service on different railroads in the United States, Canada and Mexico. These include practically all of the possible wheel arrangements and boiler designs, and in general are operating under quite similar conditions—usually on grades of one per cent. or greater.

While it is impossible to obtain in any considerable number of cases the money cost of both the Mallets and the type that they replace, under the different conditions mentioned above, it has been possible to get facts concerning the great majority of the locomotives in service which permit fair conclusions being drawn as to the relative value of the locomotives, all things considered, and in some cases cost data for certain features is also given.

Road Service.

Even a cursory investigation of the problem of the relative value of Mallet locomotives indicates that they, like all other new and larger types, must depend upon the first feature (road service) for sufficient saving to overcome the loss in the second and third features, and leave sufficient to equal or exceed the fourth consideration, and it is thus an investigation of the service on the road that largely solves the problem.

Tests to show the saving in coal and water on the ton-mile basis have been published in these columns and indicate that considerable economy can be expected along these lines, and an investigation of the facts given below will show the saving to be effected by increased tonnage per train or increased ton-miles per hour per locomotive.

The results from different roads reporting on this feature are detailed below.

Road No. 1.—On this road there were, at the time the report was made, 103 Mallet compound locomotives of three different classes having two different wheel arrangements. Two of these classes had a total weight of locomotive of 350,000 lbs. or more, the heaviest being nearly 370,000 lbs., and the other class weighed 228,000 lbs. The general dimensions of each are shown in Table I. The two heaviest classes of these locomotives, numbering 58, are being operated on 2.2 per cent. grades, twenty-five miles in length, having ten-degree compensated curves. The lighter class, of which there are 45 in service, are operated on various grades for various distances as shown in Table II.

These locomotives in this service superseded the consolidation type which had dimensions also shown in the accompanying Table I.

TABLE I

TYPE	2-6-6-2	2-6-6-2	2-6-8 0	2-8-0
CLASS	L-1	L-2	M-1	F-8
Total Weight	355000	288000	368700	192000
Weight on drivers	316000	250000	320000	180000
Cylinders	21½ & 33 x 32	20 & 31 x 30	23 & 35 x 32	20 x 32
Steam pressure	200	200	200	210
Superheater	No	No	Emerson	No
Feedwater Heater	No	No	Baldwin	No
Dia. Drivers	55	55	55	55
Tractive effort	*603 0	54500	81800‡	39090
Heating surface boiler	5700	3914	5070†	2767
Number in service	22	45	35	113

* As furnished by railroad company. † Includes feedwater heater, 1786 sq. ft. ‡ Baldwin formula.

An investigation of the tonnage handled, as given in Table II, shows that the Mallets haul from 21 to 92 per cent. greater tonnage than the consolidation, depending on the class.

The average speed of the Mallets over the division is from 15 to 16 miles per hour, and on the heavy grades about 8 miles per hour, the maximum speed being about 35 miles per hour, these all being practically the same as given by the consolidations with their lighter tonnage. For handling the same tonnage it will be seen that two Mallets will do about the same work as three consolidation engines, and it is about on this ratio that the power has been reduced on all these different divisions. This mere reduction in the number of trains on the road, even though they be longer and heavier, introduces a very large saving from every standpoint and one which it is difficult to estimate accurately. There is, of course, reduction in wages of engine and train crews, a saving resulting from the reduction of the dispatcher's difficulties, more reliable and profitable operation of passenger trains, reduction of switching movements, etc.

TABLE II

Class	Grade percent.	Length of Division	Tonage Mallet	Tonnage Consolidated	Increase percent.	Curves degree
M-1	2.2	25	850	525	62	10
L-1	2.2	25	800	535	52	10
L 2	1 0	195	1450	1100	32	10
L-2	1.8	18	800	650	23	10
L-2	2.2	48	700	550	27	10
L-2	1.0	129	1450	1200	21	4
L-2	.72	121	2200	1600	38	3
M-1	.4*	100	2500	1300	92	5
M-1	.3	100	7500	4000	87	5

* Has 6 miles of 1.6 per cent. grade.

As regards coal consumption, the folowing figures are reported by this road: On the .72 per cent. grade the coal consumption is 15.8 lbs. per hundred ton-miles, as compared with 18 to 20 lbs. for the consolidation type. On the 2.2 per cent. grade the consumption is 46.91 lbs. per hundred ton-miles, as compared to 41 to 54 lbs. On the 1 per cent. grades 16 lbs. is used on the Mallets, as compared with 19 lbs. for the consolidation. On the .3 per cent grade the Mallets operate on 4 lbs. of coal per hundred ton-miles, with 6 to 8 lbs. for the consolidation.

Figuring from the tests available, it is probable that the saving in water is about in the same or slightly larger proportion.

On this road the Mallets are run in both pooled and assigned service and are reported to be in every way as reliable as the consolidations which they replace.

Road No. 2.—This company has twenty-five 2-6-6-2 type Mallet locomotives in service. They have a total weight of nearly 400,000 lbs., of which about 325,000 lbs. is on drivers. The cylinders are 22 and 35 x 32 inches, and the steam pressure is 225 lbs. Total heating surface is 6,013 sq. ft., grate area 72.2 sq. ft. They have 56-inch drivers and the tractive effort is 82,000 lbs.

The service on this division was previously handled by consolidated locomotives having 22 x 32-inch cylinders and a tractive effort of 41,120 lbs.

The tonnage of the Mallets is 3,000 tons, which is handled over .58 per cent. grades, there being curves of 5 degrees on the ruling grades. A speed of from 25 to 30 miles per hour, with maximum of 40 miles per hour, is obtained.

Previous to the introduction of the Mallets the tonnage for the division was 1,500 tons, and as the traffic is dense, it has been possible to reduce the number of locomotives practically 50 per cent. and the number of crews has been reduced by about 35 per cent.

In regard to coal consumption, the consolidations burned 22.4 lbs. per hundred ton-miles, while the Mallets burn about 14.7 lbs. per hundred ton-miles, a saving of over 34 per cent. in coal consumed.

It is reported that up to this time the operation of the Mallets has been entirely satisfactory, they being fully as reliable on the road as the consolidations and one fireman is able to furnish sufficient steam for the full rated capacity.

Road No. 3.—On this road there are ten very large Mallets in service, four of which are equipped with superheaters, these are of the 0-8-8-0 type and have a total weight of 435,000 lbs. for the non-superheaters and 456,000 lbs. for the superheater engines. The cylinders in both cases are 26 and 41 x 28 inches. The drivers are 51 inches in diameter and the steam pressure is 220 lbs. They have a rated tractive effort of 105,000 lbs.

Previous to the introduction of the Mallets, service on the division was performed by the consolidation locomotives, having a total weight of 250,000 lbs., cylinders 23 x 30 inches, 57-inch drivers and 210 lbs. steam pressure, 50,580 lbs, tractive effort. These boilers had 3,968 sq. ft. heating surface with practically 100 sq. ft. grate area and burned culm.

The tonnage on the division of which this power is being operated is 2,800 tons with Mallets and was previously 2,600 tons with two consolidations. The ruling grade on the division is 1.4 per cent. and the curves are very short and numerous; for instance, there is an 8-degree curve on the 1.1 per cent. grade and a 7-degree curve on the 1.4 per cent. grade, and there are curves of 4 and 5 degrees where a train of 40 cars will be on two curves at the same time. Average speeds of about 10 miles per hour are maintained going up the hill.

In regard to coal consumption, compartive tests were made between the consolidations and the Mallets, and it was found that two consolidations burned 69,8 lbs. of coal per hundred ton-miles, while the Mallets required 39.2 lbs. of coal for identically the same work. Regularly assigned engines are used on this division and the service is reported as being as reliable now as formerly, with the great advantage of a reduction of 50 per cent. in the number of locomotives in service.

Road No. 4.—This company has 10 locomotives of the 0-6-6-0 type, having a total weight of 332,000 lbs. They have 20½ and 33 x 32-inch cylinders, 225 lbs. boiler pressure and 55-inch drivers and give a tractive effort of over 74,000 lbs., grate area 72.2 sq. ft. They are being operated over 4 per cent. grades 16 miles in length, and also continue on the descending grade for 11 miles, making the total distance run 27 miles. There are curves of 16 degrees compensated on the up grade.

This service was previously handled by consolidation locomotives having 195,000 lbs. on drivers, maximum tractive effort 43,180 lbs. These engines handled 269 tons at 8 miles per hour up hill and the Mallets draw 460 tons at an average speed of 7 miles per hour; this is an increase in tonnage of about 71 per cent., and three Mallets now take the place of five consolidations.

In regard to coal consumption, the Mallets give 4.83 train-miles to one ton of coal and the consolidations give 6.69 train-miles to one ton of coal. Figuring this at the full rated tonnage and 2,000 lbs. to the ton of coal, it gives 9 lbs. of coal per hundred ton-miles for the Mallets and 11.5 lbs. for the consolidations, a saving of about 22 per cent. [While the per cent. of saving figured in this way is probably fairly correct, the coal consumption figures are open to suspicion.—Ed.]

Concerning the service, it is reported that they are as reliable as the consolidations and that one fireman can furnish sufficient steam for the full rated capacity. Locomotives are operated by regularly assigned crews.

Road No. 5.—On this road there are 10 Mallet locomotives of the 2-6-6-2 type which have a total weight of 353,000 lbs. They are operating on one per cent. grades 12 miles in length, having 6-degree curves which are not compensated. They handle 2,400 tons at 10 miles per hour over this grade while the consolidations previously in use were given a tonnage of 1,600 lbs., showing a 50 per cent. increase in tonnage. No figures are furnished concerning the size of the consolidation locomotives and no data is available concerning the coal consumption. The locomotives are operated with regularly assigned crews wherever possible.

Road No. 6.—This company has 40 of the 2-6-6-2 type locomotives which weigh 304,300 lbs. on drivers and 370,200 lbs. total. two of the 2-8-8-2 type with 412,450 lbs. on drivers and ten of the 2-10-10-2 type with 550,000 lbs. on drivers and 616,000 lbs. total.

In regard to tonnage, the 2-6-6-2 type handle 2,250 tons on a .6 per cent. grade, the 2-10-10-2 type are given a tonnage of 1,900 which is operated over 1½ per cent. grade. The 2-8-8-2 type are used in pusher service only. These locomotives are being operated on various sections of the system and it is difficult to obtain a general comparison. The 2-6-6-2 type engine replaces the 2-6-2 type and the 2-10-10-2 type replaces the 2-10-2 type. It is reported that, generally speaking, two Mallets replace three of the former type; this, of course, depends considerably on the class of service and the density of the traffic at the point where it is operated.

On the smaller type Mallets which are coal burning, one fireman is easily able to handle them satisfactorily; the larger class, however, have been put in the oil regions and thus are also handled by one fireman. In regard to fuel saving. it is stated that there is a saving in favor of the Mallets, but that definite figures are not available.

Road No. 7.—Ten Mallets of the 2-6-6-2 type, having a total weight of 527,850 lbs. with 379,650 lbs. on drivers, are in operation on one division of this road. They are operated for distances of 102 miles on a division where the ruling grade is 1¼ per cent. and are rated at 1,900 tons. On the ruling grade there are curves of 4 degrees compensated. Speeds of 11 miles per hour are averaged with maximum speed of 25 to 35 miles per hour.

This service was previously performed by consolidation locomotives and each Mallet replaces 1¾ consolidation engines. The previous tonnage was 1,175 tons. It is reported that one fireman has no difficulty in maintaining full steam pressure.

In regard to coal consumption, the Mallets consume about 400 lbs. of coal per train-mile with full tonnage over the division. This gives about 21.4 lbs. per hundred ton-miles. The consolidations used about 320 lbs. of coal per train-mile, giving 27.8 lbs. per hundred ton-miles.

Road No. 8.—This company has five locomotives of the 0-8-8-0 type which have a total weight of 376,800 lbs., cylinders 24½ and 39 x 30, 200 lbs. steam pressure and 56-inch drivers, giving a theoretical tractive effort of 85,000 lbs. It also has five of the 2-8-8-2 type with same cylinders, steam pressure and drivers. Full data for a test of both these locomotives has been given in these columns.*

* June, 1911, p. 228.

These locomotives are operated on a division which has a ruling grade of 2 per cent. four miles in length and 12-degree compensated curves. They handle a tonnage of 1,180 tons at average speed from 6 to 8 miles per hour, maximum being from 10 to 12 miles per hour. This service was previously performed by the 4-8-0 and the 2-8-0 type locomotives, the former handling 600 tons and the latter 580 tons. It will thus be seen that one Mallet practically replaces two of the other type. One fireman is capable of furnishing sufficient steam for full capacity operation and the engines are operated with regularly assigned crews.

In regard to coal consumption, the Mallets consume 27.5 lbs. per hundred ton-miles as compared with the previous consumption of 42.8 lbs. per hundred ton-miles.

It is reported that the only disadvantage of the Mallets in the service is their slower speed of operation. They run about from 6 to 8 miles per hour while the previous locomotives attained a speed of 10 miles per hour.

Road No. 9.—The Mallets on this road are of the 2-8-8-2 type, having total weight of 425,900 lbs. with 394,000 lbs. on drivers, 26 and 40 x 30-inch cylinders, 200 lbs. steam pressure and 57-inch drivers, giving a tractive effort of 94,640 lbs. They are operated about 80 miles on a 2.2 per cent. grade having 10-degree curves not compensated.

Over this division one locomotive hauls 1,000 tons at an average speed of 10 miles per hour, maximum speed attained being 22 miles per hour. This service was previously performed by consolidation locomotives, 22 x 30-inch cylinders, 180,000 lbs. on drivers which had a tonnage of 480. It will thus be seen that one Mallet replaces practically two consolidations. Since oil is used for fuel there is no difficulty in maintaining full steam pressure.

In regard to fuel consumption, the Mallets burn 14.5 gal. of oil per thousand ton-miles while the consolidations consumed 18.4 gal. of oil per thousand ton-miles, thus giving over 21 per cent. of fuel economy. Figuring 168 gal. of oil as equivalent to 2,000 lbs. of coal, this gives 17.3 lbs. of coal per hundred ton-miles for the Mallets and 21.9 for the consolidations.

These locomotives were all operated in pool service and it is reported that on the road they compare very favorably with the consolidations which they replaced.

Road No. 10.—Eleven Mallets of the 2-6-6-2 type are in operation on this road over .5 per cent. grades 22 miles in length. These locomotives have a total weight of 378,650 lbs. and are given a tonnage of 4,000, which they handle at an average speed of nearly 8 miles per hour. There are 10-degree compensated curves on the ruling grade and 14-degree curves on other parts of the division.

Previous to the introduction of the Mallets, the consolidations in use were given a tonnage of 2,400 over this division. The Mallets have been able to reduce the number of engines in service by about 40 per cent. They are operated in the pool and are reported to be about 75 per cent. as reliable as the previous service. While no data is available for the coal consumption of the consolidations, it is reported that the Mallets burn 15.9 lbs. of coal per hundred ton-miles.

Road No. 11.—The eight Mallet locomotives on this road are assigned to service on a division having a 2 per cent. grade 7 miles long, where they handle a tonnage of 1,275 at an average speed of 15 miles per hour. Each one of these engines replaced two 22 x 28-inch consolidations which were only given a tonnage of 465 on this division.

It is reported that one fireman is able to develop the full capacity of the locomotives which are run in pool service. Figures of coal consumption on either class are not available. It is reported that these engines have given first-class service up to the present time.

Road No. 12.—Four oil burners of the 2-6-6-2 type handling 2,200 lbs. over a ruling grade of .73 per cent. 1½ miles in length and having 4 degree curves are in use on this road. They make an average speed of 10 m. p. h. and maximum speed of 20 m. p. h. They replace consolidation locomotives which previously handled about half of the tonnage under the same conditions.

Road No. 13.—Twenty-five of the 2-6-6-2 type locomotives having a total weight of 390,000 lbs., 23½ and 37 x 30-inch cylinders, 57-inch drivers and 200 lbs. steam pressure, giving a maximum tractive effort of 75,000 lbs., are in service on this road. On a recent test of one of these locomotives over a division 91 miles in length having grades of .5 per cent., with the exception of 1½ miles of .67. A tonnage of 2,555 tons was handled at an average speed of 5.67 m. p.h. with coal consumption of 10.96 lbs. per hundred ton-miles.

Since this was a test run and no figures are available from regular service, owing to the short time in which the locomotives have been used, it is not possible to make a comparison with any other type of locomotive.

CONCLUSIONS ON ROAD SERVICE.

In the reports quoted above where the locomotives have been in service a sufficient length of time and in sufficient numbers to make a conclusion possible, it seems that the Mallets are equally reliable with other large locomotives in the same district. It is, of course, to be expected that upon the introduction of a new type of power, especially one so entirely different from previous designs, considerable operating difficulty may be encountered until the enginemen and trainmen become accustomed to it. It is also to be expected that inasmuch as there are twice as many parts in the running gear of these locomotives, the probability of engine failures from cases originating outside of the boiler would be considerably greater. Luckily, however, the probability of trouble from the boiler is but little more than would be the case in any other large locomotive, and since a great majority of engine failures originate from this source, there appears to be no great handicap imposed in this way. As concerns derailment, if the track is of sufficient strength, no extra trouble should be experienced. On account of the largely increased power, up to the time the engineers become skilled in handling the new locomotives, it is probable that considerable trouble will be experienced in break-in-twos.

Taking the reports as a whole, however, it does not seem that any of these features have been found serious enough to justify an expressed opinion that the service of the Mallets is not equally reliable with the locomotives previously in service.

This being the case, it is then fair to assume that the saving made by the Mallets when in operation on the road is a net saving to the railroad, so far as this part of the service is concerned, especially as it can be fairly assumed that any difficulty in dispatching, due to the longer trains, is offset by the fewer number of trains on the road for the same total amount of tonnage.

In order to obtain some idea of what the exact saving of the new type of power on the road may be, the following conditions have been assumed:

A division 150 miles long with an average grade of 1 per cent.

Consolidation locomotives of sufficient size to handle trains of 1,200 tons behind the tender over this division at an average speed of 15 miles per hour.

Mallet locomotives of sufficient size to handle 2,000-ton trains over the division at an average speed of 15 miles per hour. This is about the average increase in tonnage under these conditions as shown by the reports.

It is assumed that there are 100,000 tons of cars and lading at one end of this division to be transported direct to the other end and that the conditions are such that trains at full tonnage can be dispatched at the average rate of one per hour, and that each and every train maintains an average speed of 15 miles per hour over the division.

A coal consumption of 28 lbs. per hundred ton-miles seems to be a fair figure for the consolidation locomotives under these conditions. The reports and tests indicate that a fuel economy of about 28 per cent. in pounds of coal per hundred ton-miles can be expected from the Mallets as compared with the consolidations. This gives about 19¼ lbs. of coal per hundred ton-

miles for the Mallets and for convenience a figure of 20 lbs. is assumed.

The assumption is carried further in that a sufficient number of locomotives is assured in both cases to handle the trains under the assumed conditions, and it is further considered that 6 hours will be required for delay at the terminal before the locomotive is again ready for service in the case of the consolidation and 8 hours for the Mallets.

Other assumptions are made as follows:

Wages of engine crews for the consolidations $10.00 per trip and for the Mallets $12.00 per trip. Train crew in both cases being $15.75 per trip. Cost of engine and train supplies $2.75 per trip for consolidations and $4.75 for Mallets. The coal is assumed to cost $1.50 per ton on the tender.

Under these conditions, the cost of transporting this amount of tonnage with the two different types of locomotives is given in the following table:

	Consolidation.	Mallet.	Per cent increase or decrease.
No. of trains	83	50	39.7
Total time (1 train per hour)	93 hrs.	60 hrs.	46.3
Coal burned (total tons)	2,100	1,500	28.5
Ton miles per hour	180,000	300,000	67
Cost of engine crews	$830.	$600.	
Cost of train crews	$1,307.	$787.	
Cost of coal	$3,150.	$2,250.	
Cost of supplies	$228.	$238.	
Total cost as above	$5,515.	$3,875.	29.7
Cost of above items per ton mile	$.000368	$.000258	29.7
Cost of above items per train mile	$.44	$.516	17.2

From this it will be seen that there is a total saving of $1,640 in money and 33 hours in time in transporting this amount of tonnage complete from one end of the division to the other by the Mallets. The cost per ton-mile is reduced nearly 30 per cent. and the ton-miles per hour is increased about 67 per cent.

The number of locomotives engaged in handling the freight is the same in both cases, the exact number, of course, depending upon the rapidity with which they are returned to the other end of the division.

Figuring from this data under an assumed condition of 20,000 ton-miles per hour per locomotive (average for twenty-four hours) and considering the difference in terminal delay, it appears that there is a saving of $41.66 per locomotive per day.

It will be noted that no consideration is given the return trip, as it is probable that on down grade work there will be practically no difference in the two cases if the same average speed is attained. As a general proposition is is believed that the consolidation will give a higher speed and by thus being under full tonnage a greater percentage of the time the above estimated saving will be somewhat reduced.

MAINTENANCE.

This feature consists of two parts which are generally called running repairs and shop repairs. The first including all work which does not take the locomotive out of service for any extended length of time, and in this discussion will be considered as including cleaning, adjustments and renewal of minor parts. For the purpose of investigating the matter in more detail, it will be divided into two parts: first, expense of handling and cleaning, and second, adjustments and renewals necessitated by ordinary wear and tear while in service.

As concerns handling, it probably costs little or no more so far as taking coal, water and sand and in the movement of the locomotive from the yard to the cinder pit is concerned. At the cinder pit the expense will be somewhat greater due to the larger size of the locomotive, both as regards the cleaning of the fires, ash pan and front end and also the amount of room occupied on the pit. From this point into the roundhouse the expense will be no greater for these locomotives than for a consolidation if the turntable is of a proper size. If it is not, and the locomotives have to be turned on a wye and stored in temporary structures, then, of course, the expense will run up very materially. In this discussion, however, it will be considered that the facilities are suited to this class of power and that the locomotive can be handled on the turntable without removing its tender, and that it can be run far enough into the house to permit the closing of the doors. Under these conditions, it seems fair to assume that from leaving of its train to the arrival at the pit in the roundhouse, the expense of the Mallets will be a little higher, possibly 5 per cent., than would the consolidations in size assumed above.

After arriving on the pit or while on the inspection pit outside, if this is provided, the amount of inspection is practically double that of an ordinary simple locomotive and will cost at least twice as much if properly done. Wiping the locomotive comes under the same class and will be at least twice as expensive.

The next consideration being the one which forms the greater proportion of terminal expense, is the matter of repairs and adjustments. These, of course, are the direct result of service on the road or misuse on the cinder pit or storage yard.

As concerns the difficulties which have been experienced by this class of locomotive in road service the following are reported:

Road No. 1.—No trouble with ball joints after roundhouse force became accustomed to handling the work. Flange wear is less than on consolidation locomotives. Principal difficulties with the type have been in the case of one class fitted with feed water heaters where considerable trouble has been incurred by the pitting of the flues in the heater. On this road the regular roundhouse force takes care of the work on the Mallets.

Road No. 2.—No trouble has been found with keeping the ball joints tight. Flange lubricators are not used and the flange wear seems to be less than on the consolidations. The regular roundhouse force takes care of the work on these locomotives and no features of the design have given any particular trouble.

Road No. 3.—On this road a special gang has been organized to do all mechanical work on the Mallet locomotives and these men have been trained to be specialists on this class of power, they, however, working on other locomotives when there are no Mallets in the house. No special trouble has been given by the ball joints or in fact by any other part of the locomotives. Flange lubricators are used which permit the engines to go 31,000 to 32,000 miles between tire turnings.

Road No. 4.—There has been practically no trouble with the ball joints leaking. There has been considerable trouble with flange wear although the flanges are lubricated with water. This road has also had considerable trouble with the casting that forms the articulated joint because of the bolts working loose. A great deal of trouble has been incurred by the tires wearing oblong and it has been necessary to change tires after the locomotives have made about 15,000 miles. Difficulty has also been found in various smaller matters which, however, are not peculiar to this particular design. The regular roundhouse takes care of the work on these engines.

Road No. 5.—Considerable difficulty has been found on this road in keeping the ball joints tight, and while the locomotives have not been in service any great length of time, it has not been found so far that the flange wear is any greater than on other power. A special gang has been organized in the roundhouse for taking care of the Mallets.

Road No. 6.—The experience of this road is probably the same as that of many others, that considerable difficulty was found in keeping the ball joints tight at first, but after the roundhouse force became accustomed to the work everything was all right. Flange lubricators are used and it does not appear that the flange wear is any greater on these classes. The work in the roundhouse is handled by the regular force and no troubles peculiar to the design are reported other than the one just mentioned.

Road No. 7.—In this case the regular roundhouse force takes care of all the work on the Mallets and considerable difficulty is reported in keeping the ball joints tight. The flange wear is stated to be no greater than than on the consolidation locomotives with the exception of the front drivers of the low pressure unit. Considerable difficulty has been reported in keeping the steam pipes in the combustion chamber tight and in the pitting of the flues in the feed water heater which requires their frequent renewal. It is stated that after these locomoives have

been on the side track for some time, they do not steam as freely as other types when first starting out.

Road No. 8.—A special gang is organized for taking care of the work on the Mallet locomotives so far as possible. It is reported that trouble has been given by leaky ball joints, but that the flange wear does not seem to be any greater than on other classes. Other features which have given trouble are high pressure steam pipes leaking, the rod brass wear is excessive and saddle bolts work loose. It is also reported that the locomotives are very rough riding.

Road No. 9.—Careful attention has eliminated the trouble of leaky ball joints, which was practically all of the trouble peculiar to the design that was found. Flange lubricators are used and the wear is not excessive. The regular roundhouse force takes care of the repairs.

Road No. 10.—Trouble has been found here with keeping the ball joints tight, but the flange wear is not as great on these locomotives as on others. The regular roundhouse force maintain the repairs and no difficulty peculiar to the design other than the points mentioned is evident.

Road No. 11.—In this case the power has been in service a comparatively short length of time and no difficulty has been found in keeping the bolt joints tight, but the evidence is that the flange wear will be greater than on the power replaced. The regular roundhouse force take care of the work and no special trouble has been reported.

Road No. 12.—On this road it is reported that no feature peculiar to the design has given any trouble, the ball joints have never been touched and remain tight. Tire wear is bad on the back group of drivers, but this is attributed to the special conditions under which these locomotives were operated. The regular roundhouse force maintain the repairs.

Road No. 14.—No trouble of any kind that can be attributed to the design has been reported by this road. No special gangs are organized for maintaining the power and the flange wear seems to be the same as on other types.

GENERAL REPAIRS.

In a general way the same conditions affect the cost in the shop as in the case of the running repairs. If the Mallets have two sets of four pairs of drivers, the repairs on the running gear will be more than double what they would on a consolidation, due to the additional work required by the steam and exhaust pipes, the articulated joint and the intercepting or bye-pass valve. Boiler repairs, however, will increase in about the ratio of the increased heating surface for a saturated steam engine, possibly 35 to 40 per cent. It would thus seem taken all together, so far as labor and material are concerned, that the general repairs on a Mallet locomotive would be about double that of consolidation.

In addition to the cost of labor and material, however, consideration of the length of time out of service should also be included. In some shops there will probably be very little difference in this, but in others it is probable that repairs on the Mallet will take up to 50 per cent. longer than on consolidation, the matter, of course, depending altogether on the size, organization and operation of the shop. If the surcharges of the shop are charged to the locomotives this increased time required for repairs will be an item of considerable importance, independent of the elimination of the daily saving the power could give while in service.

As to the frequency of general repairs, any difference between the two types of locomotives will, of course, depend entirely upon the thoroughness of the running repairs. In view of the assumed increased terminal delay of 33 per cent. allowed the Mallet, it will probably be fair to consider that both types will make the same mileage before general repairs, and this feature will not be given consideration.

CONCLUSIONS ON REPAIR COST.

On running repairs taken as a whole, it would appear from the reports that comparatively little trouble has been found in connection with the features peculiar to this type of locomotive. While in several cases difficulty is reported with the ball joints leaking, it is evident from the experience of others with the same design of joint that this will be largely corrected with the training of the repair force. Flange wear with very few exceptions does not seem to be excessive. It appears that the feed water heaters where applied have been a source of trouble in some cases due to the pitting of the flues. In cases where feed water heaters are not applied, it is evident from the reports that no more trouble is given by the boilers on the Mallets than on other large locomotives in the same district, and it is probable that the expense of maintaining the boilers at the roundhouse will be but little more than on other locomotives.

The maintenance of the running gear, however, comes entirely in another class, and there is no doubt but what in this particular these locomotives will cost over twice as much as simple engines, the expense being increased not only by more than double the number of parts to take care of, but also by the greater weight of the locomotive, its somewhat complicated arrangement and the usual inadequacy of the terminal facilities for taking care of it.

From this discussion it would appear to be amply on the safe side to assume that the Mallet locomotive will cost twice as much for strictly running repairs as the consolidation which it replaces. In all probability, in the majority of cases, this increased expense will be about the ratio of the increased tonnage handled per locomotive. For general repairs it is probable that the Mallet will cost more than twice as much as the consolidation.

The cost of repairs varies greatly at different points and is so dependent upon local conditions, such as quality of fuel and water, frequency of curves, class of workmen, presence of suitable facilities and design of the locomotive, that it is difficult to assume a figure which can be considered representative. Since it is the cost of these features which will determine very largely if the Mallet is going to be a paying proposition, careful investigation on this point will be required in each particular case.

From an investigation of such figures as are available for the cost of repairs under conditions similar to those assumed, it appears that a cost including both general and running repairs of 10 cents per locomotive-mile for a heavy consolidation locomotive is within reason. On this basis, it would appear that the Mallet would cost 22 cents per locomotive-mile.

Applying the conditions as assumed above and making a further assumption that the consolidation locomotive will make the run down hill at an average rate of 30 miles per hour, or 5 hours to the trip, having the same terminal delay at both ends, but that the Mallet are only to attain an average speed of 25 miles per hour and require 6 hours per trip, also have the same terminal delay at both ends, the following results are obtained.

Percentage of time in service on the road, consolidation 56 per cent., Mallets 50 per cent.; average mileage for 24 hours, 257 for the consolidation and 225 for the Mallets. Average cost of repairs per 24 hours for consolidation $25.70 and for the Mallets $49.50, an increase of $13.80 per 24 hours.

Subtracting this from the saving of $41.66 per day shown from the actual road service, it leaves a net saving for the locomotive of nearly $28.00 per day per locomotive under the assumed conditions. From this, however, should be subtracted an amount covering the loss by the increased time in the shop. This will be amply covered by $3.00 per day, leaving a net saving of $25.00 per day per locomotive when working under the assumed conditions.

Since the locations are very rare where a constant tonnage of this amount is available throughout the whole year, a percentage will have to be determined in each case, due to the decreased saving given by the Mallets when not under full tonnage and when the operation does not give the daily mileage assumed, also a reduction due to the time that both locomotives are in the shop.

For the purpose of discussion, we will assume that an average saving of this amount can be attained on 200 days in the year, giving a yearly saving of $5,000 per locomotive.

From this must be taken the interest on the increased cost of the locomotive. As compared with a consolidation locomotive capable of performing the work outlined. the Mallet would cost approximately twice as much. For discussion. the cost of the consolidation can be assumed to be about $17,000, and at five per cent. this gives a yearly capital charge of $850, which subtracted from the $5,000 obtained as the yearly saving, gives $4,150 per locomotive per year direct saving from train operation.

In view of the tests on the New York Central Lines, which are given elsewhere in this issue, it is evident that the assumptions for economy or increased capacity made herein, are very conservative. The figures given will probably apply as a fair average for a saturated steam Mallet locomotive, but it is evident that the saving will be decidedly greater when the superheater and brick arch are applied. This will be especially noticeable in the number of ton-miles per hour, since it is evident from the tests that speeds up to 30 miles per hour can be attained with nearly full tonnage.

While this whole discussion has been based on the cost of handling a certain definite amount of tonnage, this seeming to be the most logical way of treating the subject, it is probable that in most cases the economy of the locomotive will be appreciated most because of its ability to increase the capacity of a certain division, and instead of having fewer trains, it would be a case of the same number of trains with a large increase in tonnage. This is clearly demonstrated on the Pennsylvania division of the New York Central Lines where 1,400 cars are now handled by 26 Mallet locomotives while previously but 1,000 cars could be handled by 60 consolidation locomotives.

OXY-ACETYLENE WELDING*

It will not be necessary in this connection to discuss the kind of apparatus to be used, whether oxygen under high pressure or low pressure is the most economical; whether the tank storage system or retort method of handling and manufacturing is the best, or whether it is better to have the apparatus stationary and gases piped to the work or portable, to be taken whenever wanted. We have used both types and have our own ideas as to which is best. I want to state briefly that when beginning to use whichever system is decided on, there will be lots of disappointment in store for those of you who think you can get immediate results, particularly so if you are developing your own operator.

We began in an humble way about 18 months ago and thought inside of a week or two we would be welding up flue sheets, putting patches in fire-boxes, repairing castings and a hundred other things our friends had told us could be done so easily, but apparently nothing went right; a crack would be welded in one place only to open up again or start another in a different location. We had some comfort in the fact that even the so-called experts fell down, one case in particular being fresh in mind: A casting was broken which we desired to have repaired at once and, having oxygen and acetylene on the ground, thought it would be a good opportunity to let some of the people (who were so anxious to show us how it could be done) have a chance at it, which we did, and with miserable results, the operator claiming the iron was so poor that he could not get anything suitable to work on. After this, some of our men felt very discouraged at the results obtained and you could hear them saying "I told you so," but others were nearly as optimistic as I was, although after over four months' trials and tribulations, if a vote had been taken at that time, it would have been overwhelming in favor of dropping the whole thing. Finally, however, we were able to weld up some unimportant castings which gave us fresh courage. As we were having considerable trouble with cracked flue sheet bridges on certain engines, thought it would be a good thing if we could weld them up and, before trying it on a flue sheet in place, we got an old one and experimented for days with it, sometimes having more cracks at night than we started with it in the morning; at last we appeared to have solved the difficulty and started on a flue sheet in an engine, and all we had learned on the flue sheet that could expand and contract without having anything to prevent it, had to be learned over again when the sheet was held rigidly in place without an opportunity to move in any direction. We were, after considerable experimenting, at last able to handle this kind of work in a satisfactory manner, and all having experience with boiler work will appreciate what it means to be able to do a job of this kind on a flue sheet that is otherwise in good condition.

One morning we were confronted with a rush job which, if successful, would mean a good deal to us. A superheater locomotive was in the shops with a cast iron steam pipe cracked for a distance of 14 inches. Unfortunately, as it appeared at the time, we did not have a new steam pipe nor a pattern to make one, and the engine was badly needed, as engines generally are, especially when it looks as if you cannot get them. Fortunately, we had the oxy-acetylene apparatus, and after a council of war it was decided to try and weld up the steam pipe, although most of our men thought it could not be done satisfactorily. The attempt, however, was made, and much to our surprise a first-class job was the result. This gave us confidence and other jobs were undertaken, some of which turned out well and others were failures. At about this time we got hold of an operator who used his head while doing his work, and after that it was comparatively easy; nothing was too complicated to tackle and we are able to successfully weld fireboxes, apply patches, weld in half side sheets, repair broken cylinders, weld broken driving wheel spokes, built up worn parts on castings, air reservoirs, etc., repair broken castings of all kinds, so that now we cannot keep house without it. A saving of from $1,200 to $1,500 can easily be effected per month in a shop like ours by repairing things that otherwise would have found their way into the scrap; this amount simply covers the actual saving and does not in any way take into consideration the value of the time an engine or machine may be out of service.

*Abstracts from a paper by H. T. Bentley before the Western Ry. Club.

INCREASED USE OF OIL ON RAILROADS

An interesting feature shown in the report on petroleum for 1910, by the United States Geological Survey, now in preparation, is the statement of the extent to which oil enters into railroad transportation. The total length of railroad line operated by the use of fuel oil in 1910 was 21,075 miles, a trackage equivalent to that of practically five transcontinental lines stretching across the United States from ocean to ocean. Some of the lines that use oil, however, also use coal. The number of barrels of fuel oil—of 42 gallons each—consumed by the railroads of the country in 1910 is stated to have been 24,526,883. This included 768,762 barrels used by the railroads as fuel otherwise than in locomotives. The total number of miles run by oil-burning engines in 1910 was 88,318,947.

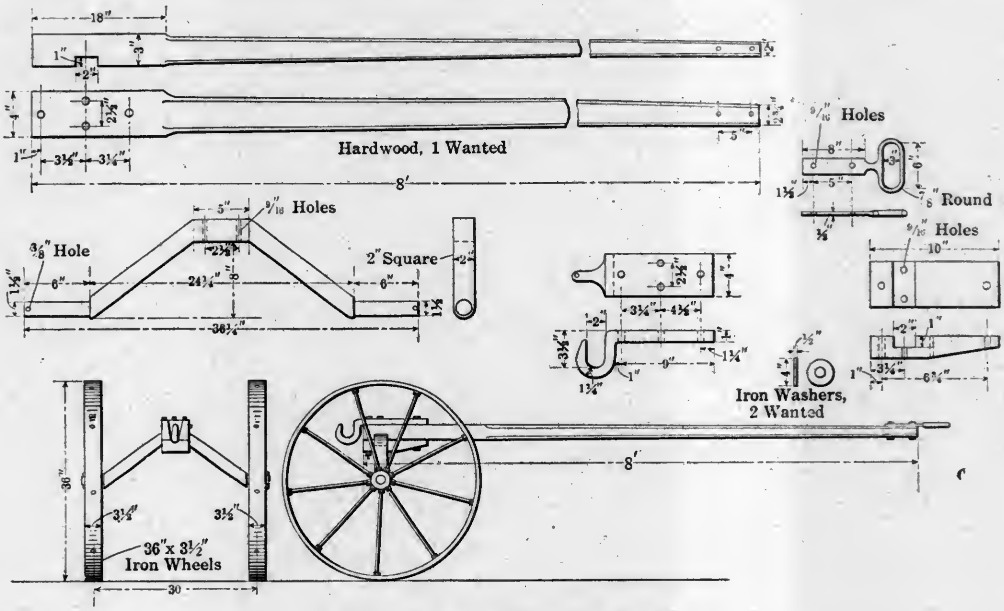
Concrete Poles are made in Germany of a hollow reinforcement of wire filled with a composition of cement, sand and asbestos, which is dried by being rotated from eight to ten minutes at 1,000 to 1,500 revs. per min. The centrifugal force exerted during this operation is said to impart density and strength to the concrete. The maximum dimensions of these poles, of which over 5,000 have been used in Dresden, Prague and Leipzig, are 46 ft. in length by 16 in. diameter.

A French Alloy, especially good for coating sheet iron for constructive purposes, consists of zinc 5.5, lead 23.5, tin 71. If it is a metal of a fine white color and high luster, 5 to 10 per cent. of bismuth may be added, making a composition of tin 90 to 95, bismuth 10 to 15. An admixture of one-half, or at most 1½, per cent. of iron in tin greatly increases its hardness and durability.

TWO USEFUL SPECIAL DEVICES

Charles Markel.*

Although the design and construction of hand trucks for moving weighty parts from place to place about locomotive terminals are both practically as numerous and varied as the individual shops themselves, it is nevertheless believed that the one herewith illustrated will prove of interest. It is intended for the easy carriage of pistons, main and side rods, driving boxes, etc.; in fact, anything portable which the distance between the hook and the floor will permit.



HANDY SHOP OR ROUNDHOUSE TRUCK.

As the drawing clearly indicates, the predominant characteristic of this arrangement is extreme simplicity. With the exception of the two 36 by 3½-in. iron wheels the parts are readily within the resources of any shop, and the cost of assemblage is inconsequential. The very great leverage exerted through the 8-ft. handle, in view of the proximity of the weight hook to the fulcrum point, permits of very heavy parts being picked up with the greatest ease. The capacity of this truck will allow it to take two large steam pipes at one load, if necessary, four guide bars, or in fact any erecting shop combination which in many cases are trucked singly.

From the labor-saving viewpoint alone these trucks are of great value in roundhouse work, and should be considered part of the equipment of that department. Ordinarily, unless the load is excessive, one man can readily take care of it, the advantage of this being manifest in the fact that the drop pit gang is not temporarily weakened by the absence of two or three helpers which without the device would be required to get the driving boxes or parts to be repaired into the machine shop.

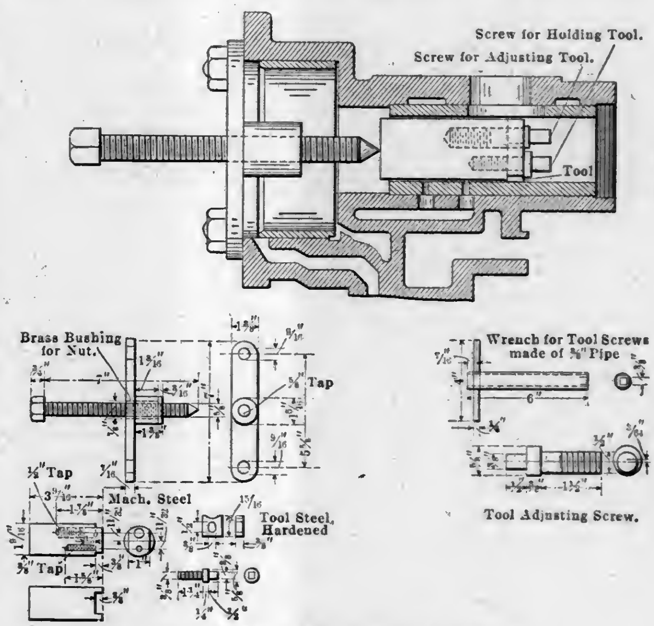
The facing tool for distributing valve, E-T equipment, is a very clever device and merits special attention. It is intended for use in reducing or lowering the face of the bushing on the distributing valve. It will be recalled that this brass bushing has a flat seat 5 in. long, and that as the valve only travels on this seat 3 in., a shoulder is left at the end of the valve travel. Consequently when this seat requires facing, which is of not infrequent occurrence, it must be faced and scraped for the full five inches. The object of the tool shown herewith is to remove this shoulder and also any amount of metal below the surface of the original seat. The amount recommended in the last named procedure is 1/32 in., which, experience has demonstrated, will last for some time.

The tool is simply a round piece of machine steel, and the details may be readily understood from the drawing. It is turned up to fit the bore of the bushing, and on one end it is planed to fit the tool steel cutter, the latter being held in place by a ⅜-in. bolt. The tool is fed to its work by a ½-in. screw bolt, which has an eccentric shoulder to engage in a groove at the top of the tool or cutter. The latter is then forced by the screw and yoke as illustrated.

This is regarded as an indispensable special device to the air brake repair department, doing its work quickly and perfectly, and with a minimum of the time and labor formerly expended.

* Foreman, Clinton Shop, Chicago & North Western Ry.

A Noted Expert in Boiler Design has expressed the opinion that it is far better to make the butt-straps of a boiler narrow, and correct the weaknesses in the seam by making the butt-straps thick, and thus prevent cracking and similar mishaps with riveted joints.



FACING TOOL FOR DISTRIBUTING VALVE.

The Highest Bridge in the World is that over the Sionle gorge, between Montloon and Clermont-Ferrard, France, its height being 450 feet.

New Electrical System of Cab Signalling

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Cab-signaling has not been viewed with any particular favor on railroads of this country for several good and sufficient reasons, prominent among which are that it admittedly necessitates extremely delicate appliances in the face of quite stringent requirements, and because the scheme of railroading as here practised is presumed to achieve better results by not depriving the engineer or any other employee entirely of the initiative.

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FIG. 1.

at this time considerable attention on foreign roads, particularly on those of England, where at least several experimental installations have been made. As, of course, is well known, that country in certain seasons of the year experiences fog to a degree unknown here and this naturally endows a successful form of cab-signaling with greater value than could be associated with it under the more favorable weather conditions prevailing in the United States. In times of heavy fog in England it becomes necessary to put on additional signalmen to facilitate the train movement, and even then the latter is frequently very seriously interfered with. This no doubt explains why so much attention is being given to the development of a system through which the positions of the fixed signals may be faithfully reproduced in miniature in the engine cab, thus permitting schedule speed to be at least approximately maintained.

According to the *Railway Engineer*, of London, such a system, known as the Raven Electrical Cab Signal, has been installed on the Richmond Branch of the North Eastern Railway. All the engines working on that branch have been equipped, and after satisfactory tests, the system was formally opened on August 14th last, and fog-signalmen were dispensed with. Although embodying what might be considered features of complexity, this arrangement presents nevertheless an interesting study as indicative of the progress which has been made in the art of cab-signaling.

At every signal tower there are provided on each line at least four bars similar to that illustrated in Fig. 1. One of these is placed about 150 yards in the rear of the distant signal, a second is fixed in the rear of but close to the distant, and a third of similar construction is located midway between the distant and home signals, while the fourth is just in the rear of the home signal. When there is a starting signal a fifth bar is also provided in the rear of it. These bars are T-section steel and are supported by wooden blocks laid on porcelain insulators carried on the sleepers. At stop signals the bars are about 60 ft. in length, while the other bars are about 30 ft. long. Fig. 2 is the engine apparatus in which it will be seen that in the middle is a shoe carried by links. To the middle of the shoe is connected a lever coupled at the other end to a switch working in the switch-box seen on the left in Fig. 2. The shoe is kept down normally by a spring above it. On either side of the apparatus are metallic brushes carried by the same frame as the shoe and the frame, shoe and brushes are further kept down

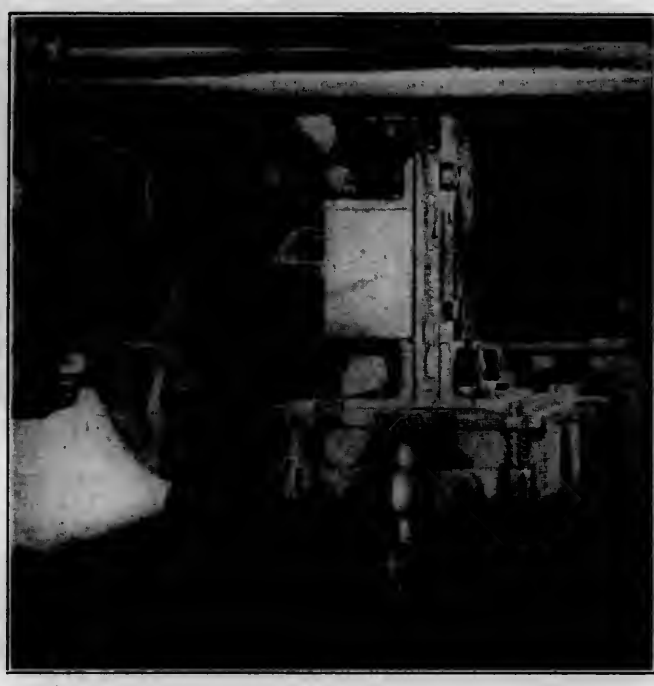

FIG. 2.

by a spring at each of the four corners, two of which are shown in Fig. 2. The contact making apparatus is insulated from the engine frame.

In the engine cab, Fig. 3, on the left, is a visible indication, and on the right a bell and switch. Below the bell by the side of the reverse lever is a battery box. An enlarged view of the indicator is given in Fig. 4. The miniature arm gives two indications—danger and clear. The route indicator below shows whether, at a junction, the road is set to the left or right at places other than junctions the indicator inclines to the left and is deflected for every signal.

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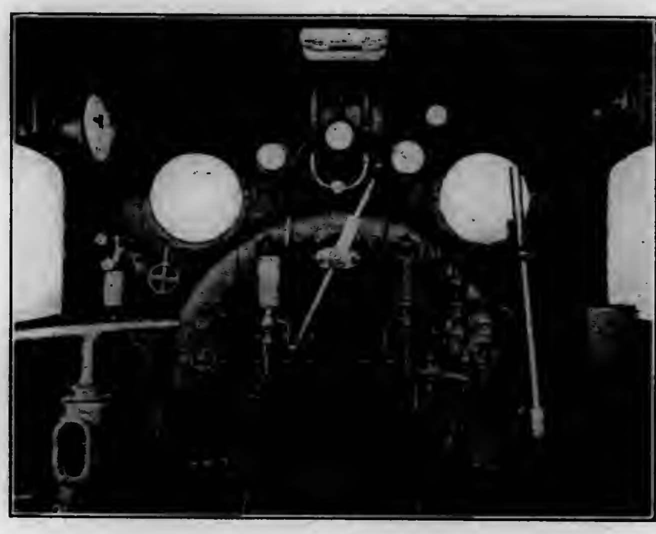

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Another condition is, of course, possible, which is that the train may be delayed waiting for the section ahead to be cleared. If so, the home signal would be lowered after the train had been brought to a stand and then it be allowed to move forward to the starting signal. The arrangement is, however, such that the bell must ring—except when the engine is on a bar—and the miniature arm must remain up as long as a train is between the first bar and the starting signal, unless both the home and starting signals are clear. In this condition the following would be the procedure:

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Thus is briefly described what is apparently an efficient cab-signaling installation and its subsequent performance will no doubt be awaited with interest. As above outlined, the scheme in general carries a particular appeal where the ordinary signals cannot be readily observed due to peculiar climatic conditions, but the fact must remain that the original cost of such an arrangement must be very great and its maintenance an expenditure scarcely warranted by the benefits derived.

In general all apparatus for cab-signaling should be simple, positive, easily maintained, easily replaced, and yet able to stand the rough and tumble to be found in railway work. This latter means exposure to dust, dirt, rough usage, and all sorts of climatic conditions. Above all, the apparatus must be reliable and, in the rare event of failure, must so face that the danger signal is shown and must be observed.

SINCE 1900 THE PENNSYLVANIA RAILROAD SYSTEM has avoided grade crossings in all new construction work and has been doing away with those already in existence as rapidly as possible. Many millions have been spent in this work, with the result that 673 grade crossings were eliminated from the Lines East of Pittsburgh between January 1st, 1900, and September 1st, 1909.

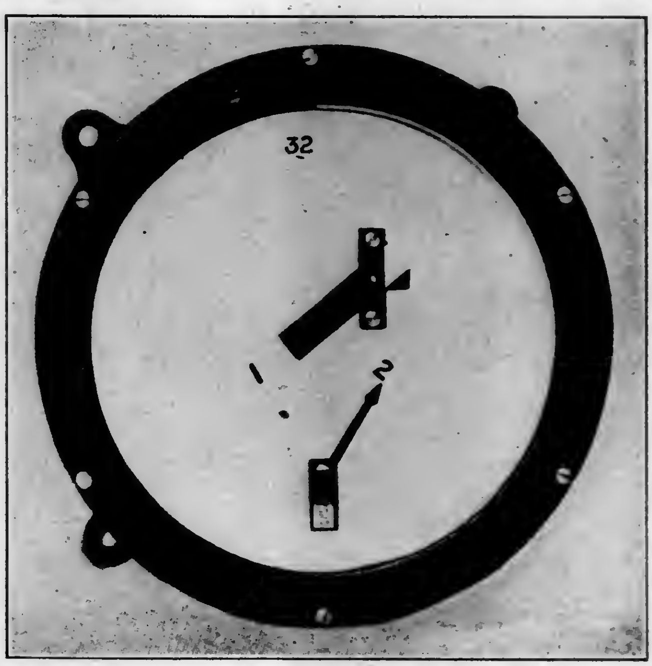

FIG. 4.

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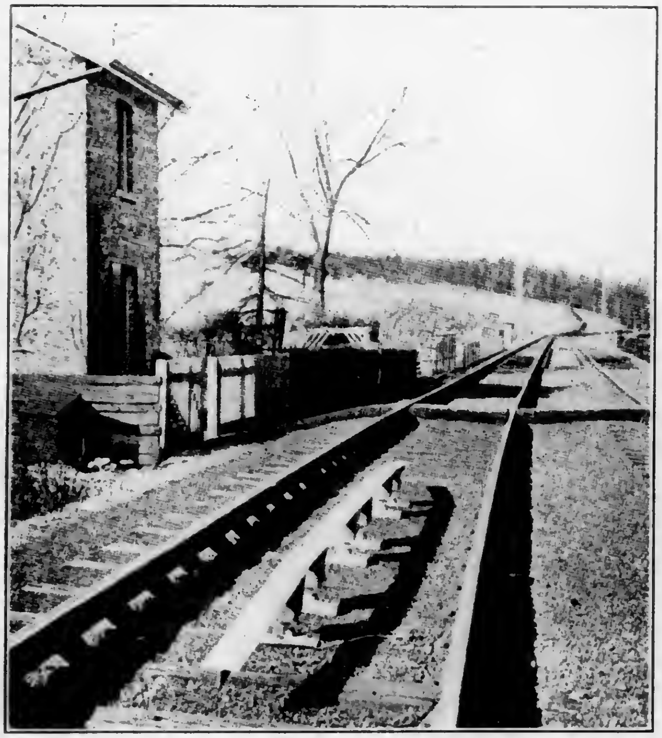

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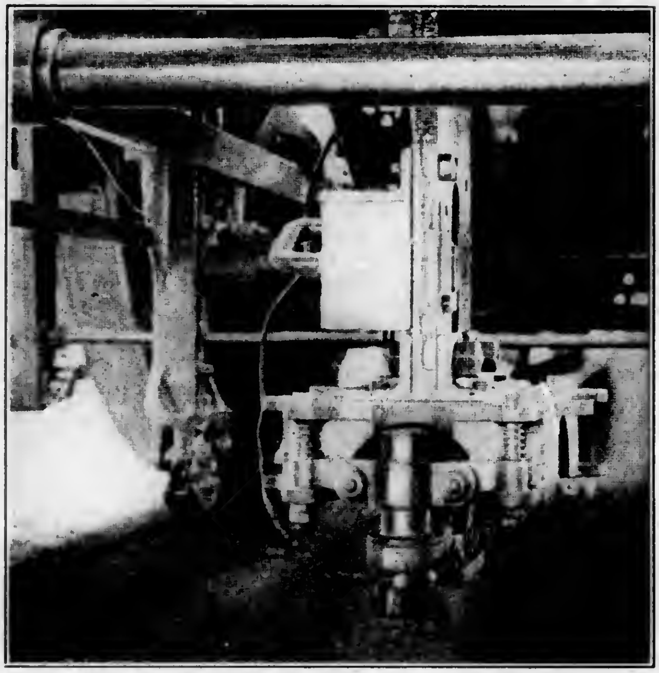

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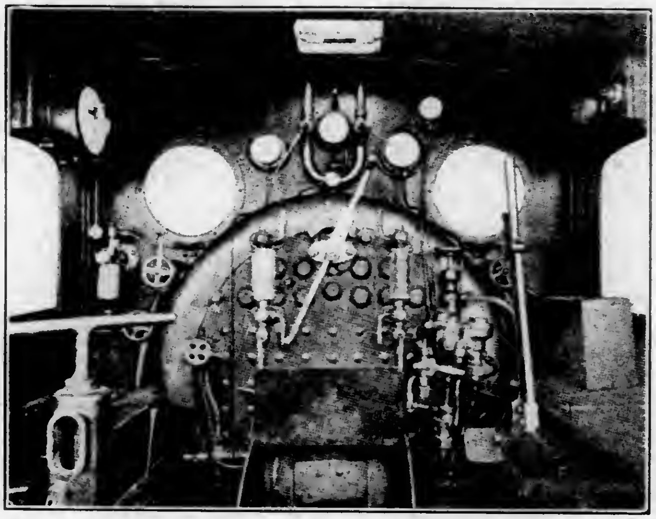

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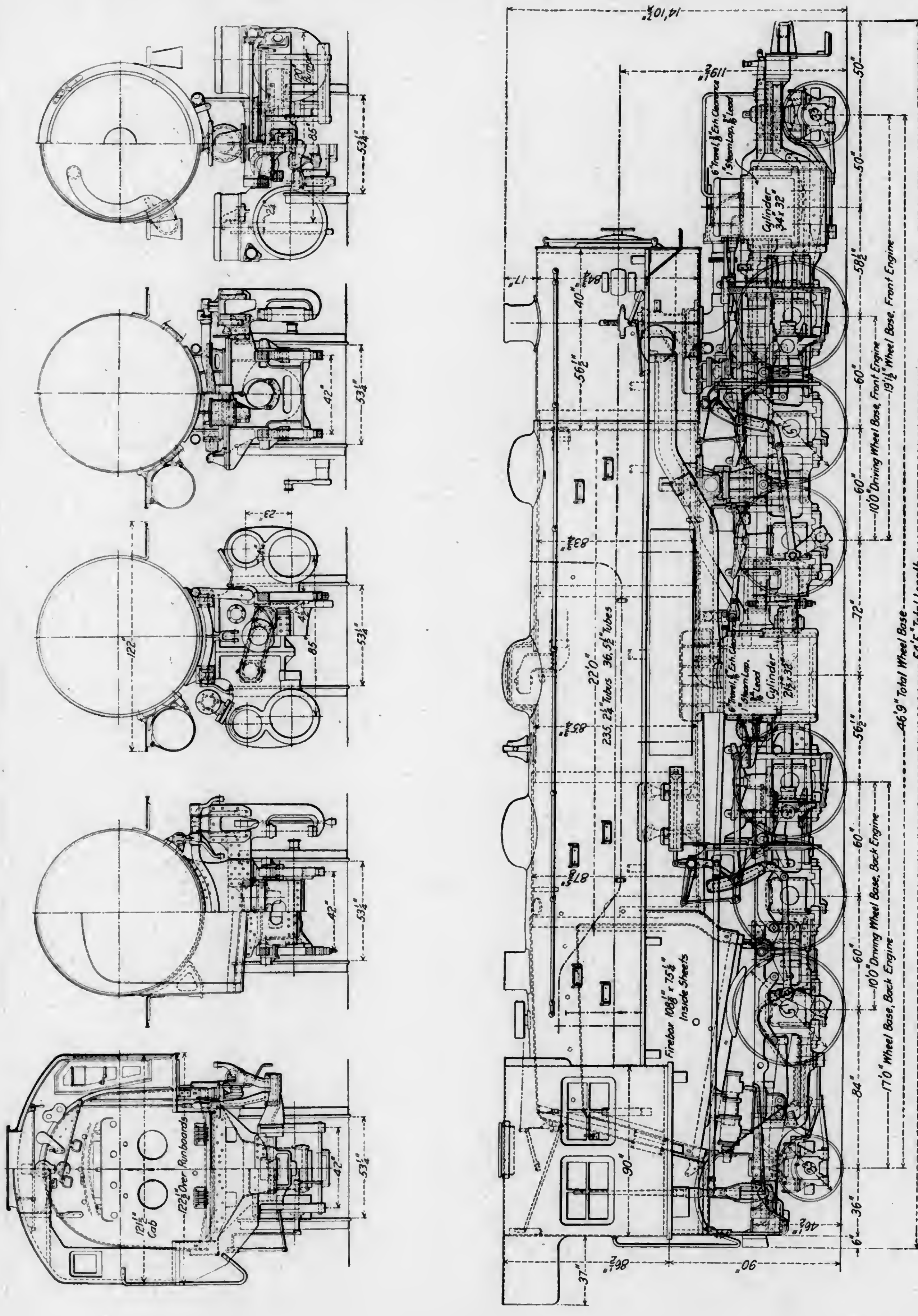


DESIGN OF 2-6-6-2 TYPE LOCOMOTIVE BASED ON RESULTS OF ELABORATE SERIES OF TESTS ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

Test of a Mallet Locomotive Equipped With Superheater and Brick Arch

NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

On the Pennsylvania division of the New York Central and Hudson River Railroad, a large volume of slow freight traffic is handled over a single track having fairly heavy grades and numerous curves. The motive power has been heretofore largely of the consolidation type designated as class G-6-G which have a total weight of 236,000 lbs. and a tractive effort of 45,700 lbs. There were 60 locomotives of the class in service, of which 31 were used for pulling trains and the remainder for pusher service.

Traffic became so dense on the division that the maximum capacity of the single track was practically reached, and if any increased business was to be handled it would be necessary to either double track or increase the weight of the trains by the adoption of heavier motive power.

Early in 1910 the American Locomotive Co. designed and built a Mallet compound locomotive for the Boston and Albany Railroad which it was proposed to use on a certain section of that line,* and it seemed advisable to the management to investigate the possibilities of this type of locomotive in solving the problem on the Pennsylvania division. It was therefore transferred to that point and careful tests carried out on both the Mallet and the consolidation.

These tests indicated that the Mallet would give considerable economy in fuel per unit of work as compared with the consolidation when operating under the conditions for which it was originally designed, viz., low speed, heavy freight work. The conditions on the Pennsylvania division, however, demanded higher speeds and the testing committee recommended the application of a superheater. The locomotive was then returned to the Schenectady plant of the American Locomotive Company, and equipped with a Schmidt superheater and "Security" brick arch, and some minor changes were made as the tests had shown advisable. It was then returned to the company and the second series of tests were carried out and upon their completion the committee consisting of representatives of the Pennsylvania Railroad, the American Locomotive Company, and the New York Central and Hudson River Railroad, made a report in which appeared the following conclusions upon the advantages of the type:

"Economy in train operation due to larger output in ton-miles per locomotive."

"Greater economy in coal per unit of power due to the larger boiler available and especially to the use of compound cylinders and superheated steam."

"Judging from the construction of the parts of this locomotive and its riding qualities, with the ability to take curvatures as represented on the dvision over which the tests were made, there would seem to be no reason to expect any undue injury to the locomotive itself when running at a speed of 30 miles per hour."

"As to the injury to the track at speeds of 30 miles per hour, the weight per axle for the Mallet is very much below that which is the common practice for passenger engines, where as high as 60,000 lbs. per axle is often employed, and from this standpoint it is considered that no undue injury would be occasioned to a track suitable for consolidation locomotive similar to the G-6-G class."

MALLET LOCOMOTIVE WITH SUPERHEATER IN SERVICE ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

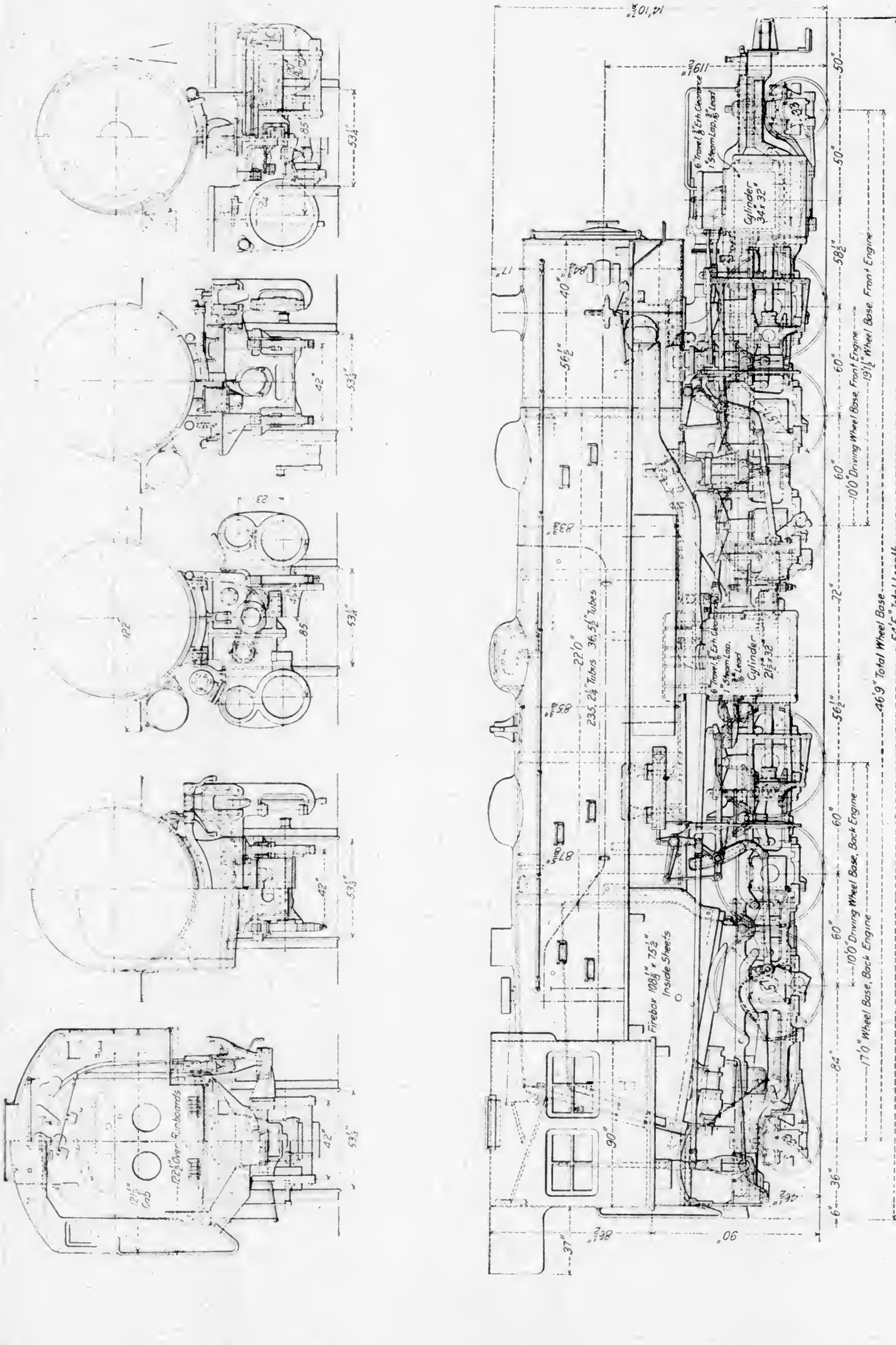
The result of these tests led the New York Central to purchase 25 more of the same type which are now in service. These were built to practically the same specifications as the one tested except that both the high and low pressure cylinders were increased by about 1 inch and the boiler pressure was reduced by 10 lbs. The general dimensions of the locomotives finally ordered, as well as the one tested and the New York Central G-6-G consolidation and the Pennsylvania H-8-B consolidation locomotive, which were tested in comparison, are given in the accompanying Table 1.

At present the 26 Mallet locomotives are handling the traffic on this division which previously required 60 consolidations. A single Mallet hauls a 4,000-ton train over the division without assistance where previously the maximum tonnage was 3,500 tons which required pusher assistance on the heavier grades. With this increased load the trains daily over the division have been decreased by ten and the overtime has been reduced 80 per cent. It has been found that the Mallet saves on an average of 35 per cent. in fuel per ton-mile. This stated in another way means that 54 per cent. more ton-miles per ton of coal are obtained by the Mallet than by the consolidations which they replaced. The operating capacity of the division has been increased over 40 per cent., *i. e.*, that while formerly 1,000 cars daily was the maximum, 1,400 cars can now be handled in 24 hours.

Altogether the tests extended over a period of 2½ months and every possible refinement leading to accuracy was used. The dynamometer car of the Pennsylvania Railroad* was used and the trains provided were carefully arranged to suit the conditions desired. The tests were made over a portion of the road from Avis Yard, Jersey Shore, to Stokesdale Jct., Pa., a distance of 63.07 miles. It will be seen by the profile that this is on a continuous up-grade and all runs were confined exclusively to the north-bound movement, the engines being turned at Stokesdale and returned light to Avis. The observations were begun at Toburt, 9.67 miles north of Avis, giving this time for getting

* For full illustrated description, see AMERICAN ENGINEER, April, 1910, p. 135.

*See AMERICAN ENGINEER, August, 1907, p. 298.



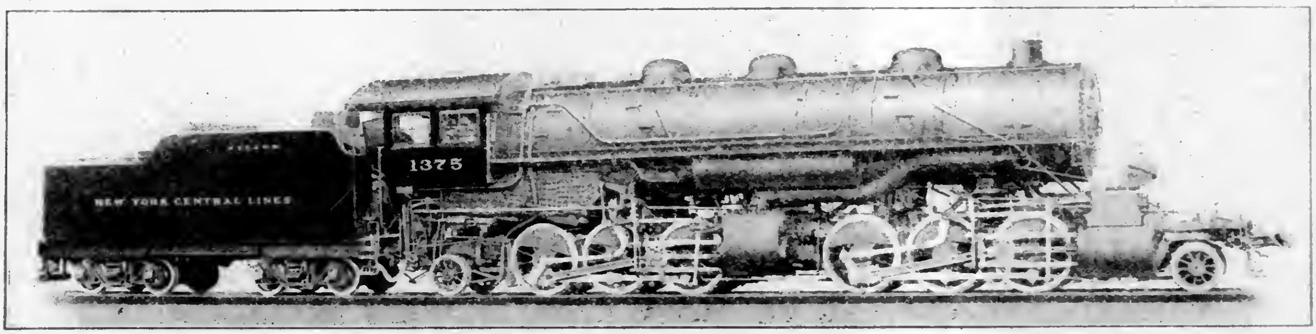
DESIGN OF 2-6-6-2 TYPE LOCOMOTIVE BASED ON RESULTS OF ELABORATE SERIES OF TESTS ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

Test of a Mallet Locomotive Equipped With Superheater and Brick Arch

NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

On the Pennsylvania division of the New York Central and Hudson River Railroad, a large volume of slow freight traffic is handled over a single track having fairly heavy grades and numerous curves. The motive power has been heretofore largely of the consolidation type designated as class G-6-G which have a total weight of 230,000 lbs. and a tractive effort of 45,700 lbs. There were 60 locomotives of the class in service, of which 31 were used for pulling trains and the remainder for pusher service.

Traffic became so dense on the division that the maximum capacity of the single track was practically reached, and if any



MALLET LOCOMOTIVE WITH SUPERHEATER IN SERVICE ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

increased tonnage was to be handled it would be necessary to either double track or increase the weight of the trains by the adoption of heavier motive power.

Early in 1910 the American Locomotive Co. designed and built a Mallet compound locomotive for the Boston and Albany Railroad which it was proposed to use on a certain section of that line,[1] and it seemed advisable to the management to investigate the possibilities of this type of locomotive in solving the problem on the Pennsylvania division. It was therefore transferred to that point and careful tests carried out on both the Mallet and the consolidation.

These tests indicated that the Mallet would give considerable economy in fuel per unit of work as compared with the consolidation when operating under the conditions for which it was originally designed, viz., low speed, heavy freight work. The conditions on the Pennsylvania division, however, demanded higher speeds and the testing committee recommended the application of a superheater. The locomotive was then returned to the Schenectady plant of the American Locomotive Company, and equipped with a Schmidt superheater and "Security" brick arch, and some minor changes were made as the tests had shown advisable. It was then returned to the company and the second series of tests were carried out and upon their completion the committee, consisting of representatives of the Pennsylvania Railroad, the American Locomotive Company, and the New York Central and Hudson River Railroad, made a report in which appeared the following conclusions upon the advantages of the type:

"Economy in train operation due to larger output in ton-miles per locomotive."

"Greater economy in coal per unit of power due to the larger boiler available and especially to the use of compound cylinders and superheated steam."

"Judging from the construction of the parts of this locomotive and its riding qualities, with the ability to take curvatures as represented on the division over which the tests were made, there would seem to be no reason to expect any undue injury to the locomotive itself when running at a speed of 30 miles per hour."

"As to the injury to the track at speeds of 30 miles per hour, the weight per axle for the Mallet is very much below that which is the common practice for passenger engines, where as high as 60,000 lbs. per axle is often employed, and from this standpoint it is considered that no undue injury would be occasioned to a track suitable for consolidation locomotive similar to the G-6-G class."

The result of these tests led the New York Central to purchase 25 more of the same type which are now in service. These were built to practically the same specifications as the one tested except that both the high and low pressure cylinders were increased by about 1 inch and the boiler pressure was reduced by 10 lbs. The general dimensions of the locomotives finally ordered, as well as the one tested and the New York Central G-6-G consolidation and the Pennsylvania H-8-B consolidation locomotive, which were tested in comparison, are given in the accompanying Table 1.

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Altogether the tests extended over a period of 2½ months and every possible refinement leading to accuracy was used. The dynamometer car of the Pennsylvania Railroad* was used and the trains provided were carefully arranged to suit the conditions desired. The tests were made over a portion of the road from Avis Yard, Jersey Shore, to Stokesdale Jct., Pa., a distance of 63.07 miles. It will be seen by the profile that this is on a continuous up-grade and all runs were confined exclusively to the north-bound movement, the engines being turned at Stokesdale and returned light to Avis. The observations were begun at Toburt, 9.67 miles north of Avis, giving this time for getting

[1] For illustrated description, see AMERICAN ENGINEER, April, 1910, p. 135.

*See AMERICAN ENGINEER, August, 1907, p. 293.

the locomotive in condition and the fire built up before taking observations. The remaining distance has in it 1.16 miles of descending grade occurring at two points and 4.5 miles of level track distributed over six places.

The two consolidation locomotives were so similar that for

TABLE 1.—GENERAL DIMENSIONS OF LOCOMOTIVES TESTED.

	N. Y. C. Consolidation. Class G.6.G.	P. R. R. Consolidation. Class H.8.B.	Mallet as Modified in Second Test.	Mallet as Finally Ordered.
Maximum tractive effort, lbs....	45,700*	45,300*	66,600	67,500
Maximum tractive effort (working simple) lbs.	......	......	79,900	81,000
Wt. on driving wheels, lbs......	211,000	211,700	304,500	301,500
Wt. on leading truck, lbs........	25,000	26,900	25,000	26,000
Wt. on trailing truck, lbs.......	......	......	22,500	26,500
Wt., total of engine, lbs.........	236,000	238,600	352,000	354,000
Wt. of tender, lbs..............	147,400	158,000	152,700	153,700
Wt., total of engine and tender, lbs.	383,400	396,600	504,700	507,700
Wheel base, rigid, ft. and in....	17- 6	17- ½	10-0	10-0
Wheel base, driving, ft. and in..	17- 6	17- ½	30-8½	30-8½
Wheel base, total of engine, ft. and in.	26- 5	25-9½	46-4	46-9
Wheel base, total of engine and tender, ft. and in.............	60-11½	59-5⅝	74-8	75-8
Cylinders, diameter, in..........	23	24	20½ & 33	21½ & 34
Cylinders, stroke, in............	32	28	32	32
Wheels, diameter of driving, in..	63	62	57	57
Wheels, diameter of truck, in....	33	33	33	33
Wheels, diameter of trailing, in..	..	..	33	33
Wheels, diameter of tender, in..	33	36	33	33
Boiler pressure, lbs. per sq. in...	200	205	210	200
Boiler, type	St. top	Belpaire	St. top	St. top
Boiler, outside diameter, in.....	82	80	83¾	83¾
Firebox, length, in..............	108⅛	110¼	108⅛	108⅛
Firebox, width, in..............	75¼	72	75¼	75¼
Tubes, number	446	465	235—2¼ 36—5½	235—2¼ 36—5½
Tubes, diameter, in.............	2	2	2¼ & 5½	2¼ & 5½
Tubes, length, ft. and in........	15-½	15.0	22.0	22
Heating surface, tubes, sq. ft....	3,512	3,665.91	4,168	4,168
Heating surface, firebox, sq. ft...	184	181.0	185	197.9
Heating surface, water tubes, sq. ft.	27	..	13	27.1
Heating surface, total, sq. ft....	3,702	3,846.91	4,366	4,393
Superheating surface, sq. ft.....	...	...	966.3	966.3
Grate area, sq. ft...............	56.5	55.05	56.5	56.5
Tender, water capacity, gals....	7,500	7,000	8,000	8,000
Tender, coal capacity, tons.......	12	17½	12	12

*Calculated on the basis of a mean effective pressure of 85 per cent. of the boiler pressure.

the purposes of comparison, the average results obtained are given in the accompanying tables.

Coal of excellent and uniform quality was used, a greater proportion of it coming from the same mines. The average of the samples analyzed is given at the top of the next column.

In Table 2 are given general results obtained from the tests. It will be seen that comparative figures are obtained at two different speeds, and that results of the Mallet at 17½ miles

ANALYSIS OF COAL.

Volatile matter....................................	25.26%
Fixed carbon.....................................	64.28%
Ash	10.44%
Moisture	3.44%
Sulphur	1.92%
B.t.u. (dry coal)..................................	13,800

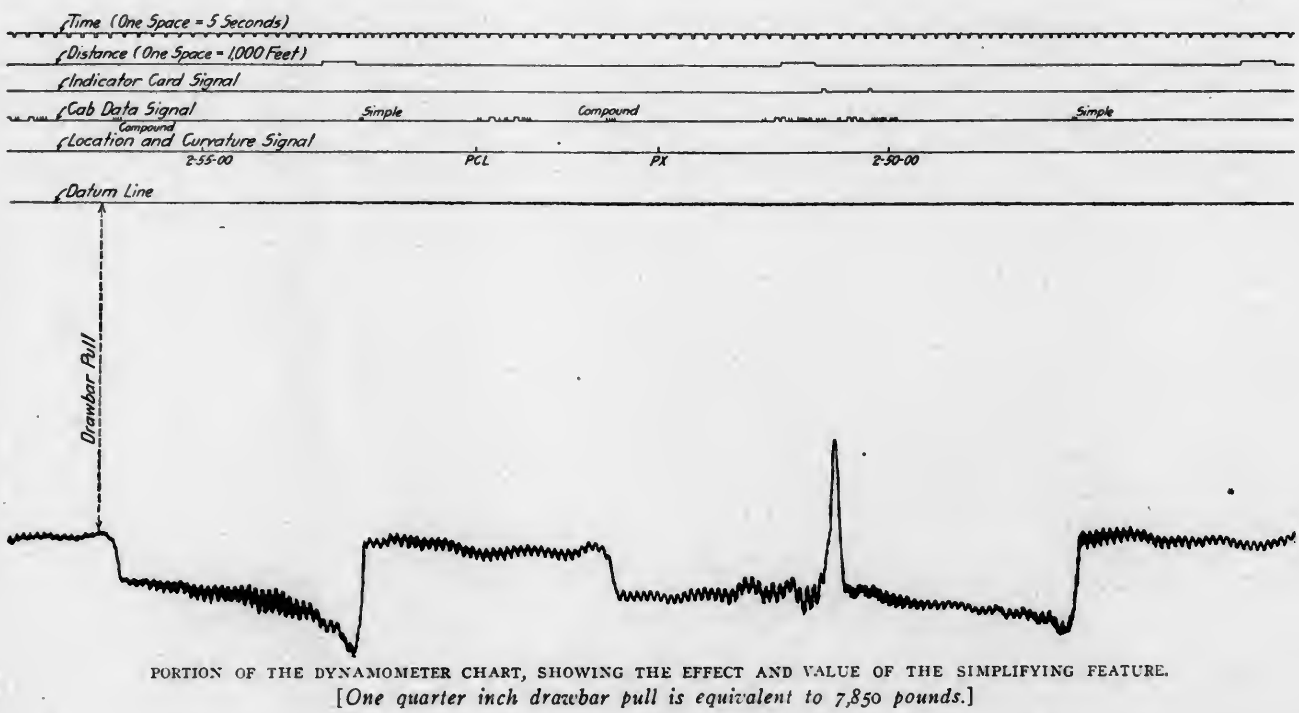
per hour and of the consolidation at 21 miles per hour are also given.

The most important feature shown in this table is given in connection with the amount of coal burned per ton-mile where an economy of 36.6 per cent. in favor of the Mallet is shown. This feature is more strikingly brought out by the comparison shown in Table 3, where the ton-miles per ton of coal in each case are

TABLE 2.—COMPARISON OF GENERAL PERFORMANCE OF MALLET AND CONSOLIDATION LOCOMOTIVES UNDER DIFFERENT SPEED CONDITIONS.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations,
Number of cars............	12.5	41.5	65.3	57.3
	15.0	36.7	58.2	58.6
	17.5	....	40.	....
	21.0	25.5	....	....
Average weight per car, tons	12.5	60.15	57.2	....
	15.0	55.12	59.5	....
	17.5	.....	64.7	....
	21.0	60.47	....	....
Total tonnage behind tender.	12.5	2,495.5	3,734	49.6
	15.0	2,017.5	3,461	71.5*
	17.5	....	2,588	....
	21.0	1,542	.....	....
Total elapsed time, hours....	12.5	5.89	6.86	....
	15.0	4.65	5.00	....
	17.5	3.51	4.51	....
	21.0	....	....	....
Running time, hours........	12.5	4.605	4.58	....
	15.0	3.765	3.87	....
	17.5	.....	3.37	....
	21.0	2.82	....	....
Average speed, running time, m.p.h.	12.5	12.75	12.9	....
	15.0	15.7	15.2	....
	17.5	....	17.5	....
	21.0	21.4	....	....
Coal per ton-mile, lbs.......	12.5	0.1275	0.077	39.6
	15.0	0.1392	0.084	39.6
	17.5	......	.....	....
	21.0	0.1418	0.086	....

*This relatively higher percentage in favor of the Mallet is probably due to the fact that the consolidations were not loaded to their full capacity at 15 miles per hour.



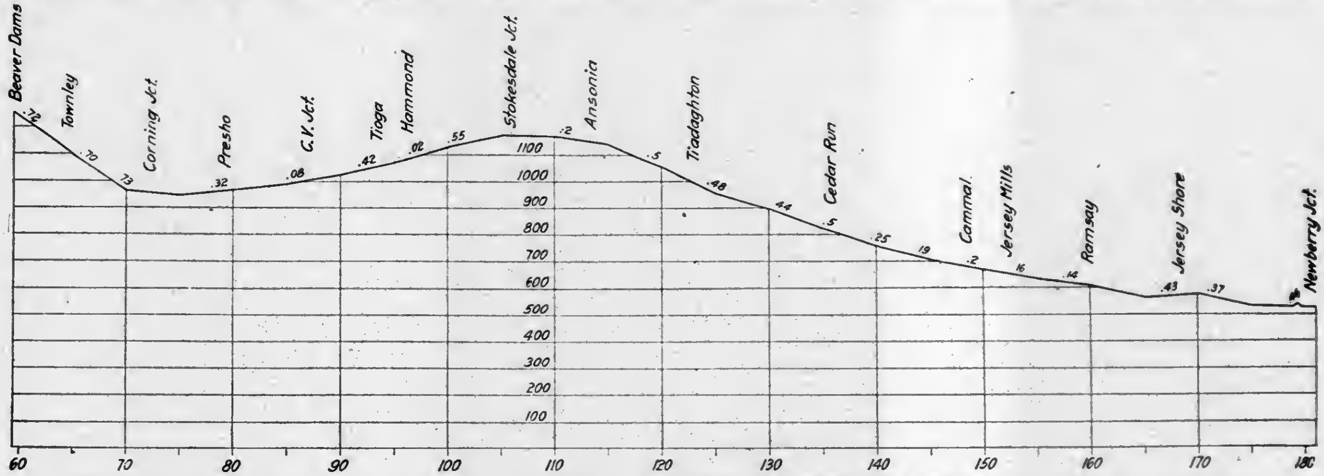
PORTION OF THE DYNAMOMETER CHART, SHOWING THE EFFECT AND VALUE OF THE SIMPLIFYING FEATURE.
[*One quarter inch drawbar pull is equivalent to 7,850 pounds.*]

given, showing the minimum of 61.2 per cent. advantage of the Mallet over the average of the two consolidations.

Another interesting fact shown in Table 2 is that within the range of speeds in which it is operated in actual service, the increase in the normal theoretical maximum tractive effort of the Mallet as compared with the simple is fully realized. With the theoretical tractive effort 45 and 47 per cent. greater than the two consolidations tested, the Mallet hauled approximately 49 per cent. more tonnage than the average of the two at speeds of 12½ miles per hour. On these runs both the consolidations were loaded to their full capacity. At speeds of 15 miles per hour it is believed that the consolidations did not have the maximum tonnage that they could haul and it is probable that the tonnage of 12½ miles per hour is a more accurate measure of the capacity.

In order to determine exactly the advantage of the system of compounding used, one run was made with the maximum train load which the Mallet would haul over the division without stalling, the train consisting of 63 steel cars and a caboose, making a total weight of 4,465 tons behind the tender. This run clearly demonstrated the great advantage of the reserve capacity available with this system of compounding which makes it possible to secure 20 per cent. increase of power by the use of the steam direct from the boiler in both the high and low pressure cylinders by virtue of its distinctive features—the separate exhaust from the high pressure cylinders and the intercepting valve.

By means of these special devices, the back pressure on the high pressure cylinders is reduced when working simple and increased power is secured without sacrificing the equal distribution of the work between the two engines.



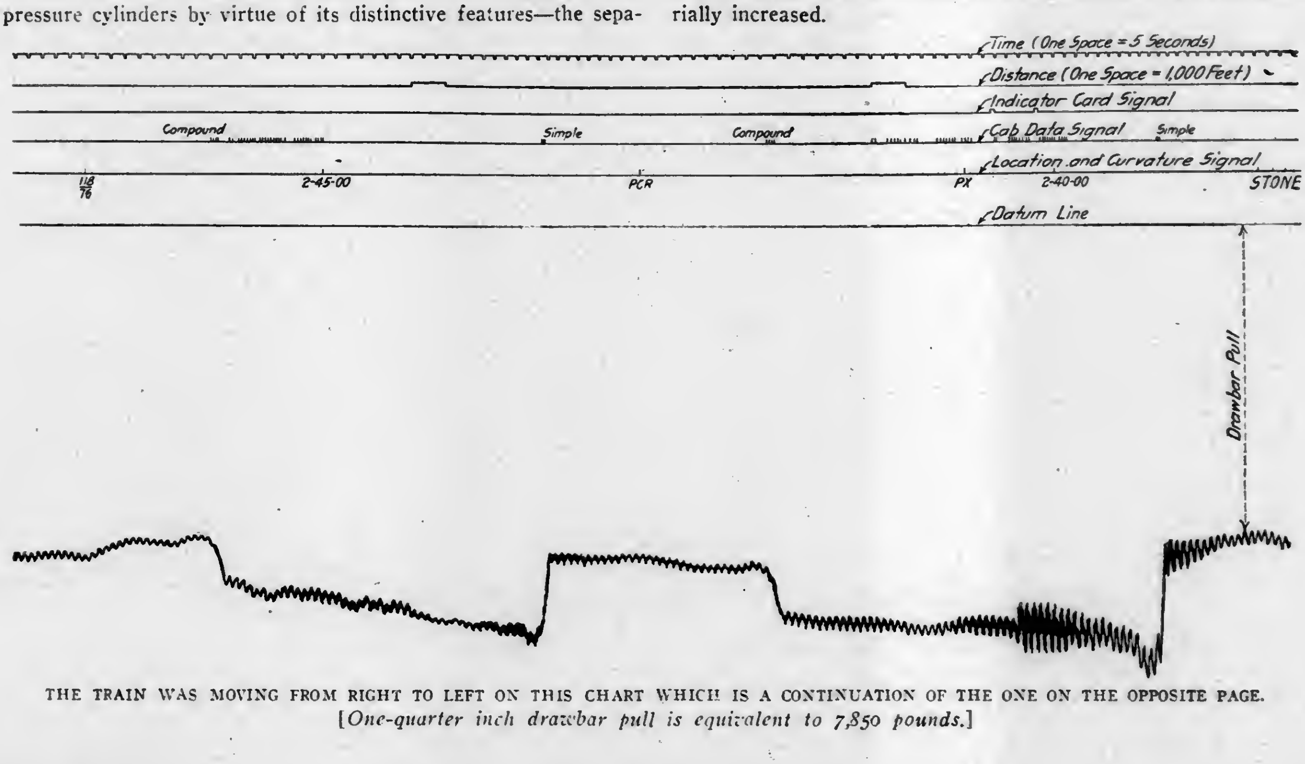
PROFILE OF THAT PART OF THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL ON WHICH THE MALLET LOCOMOTIVES WERE TESTED.

With this reserve power in use at several points, an otherwise prohibitive train load was taken over the division without stalling. During the run the locomotive was simpled approximately 8 per cent. of the time the throttle was open and an average speed of 10.6 miles per hour was made.

TABLE 3.—COMPARATIVE PERFORMANCE IN TON-MILES PER TON OF COAL OF MALLET AND CONSOLIDATION LOCOMOTIVES.

Approximate average speeds.	Ton-Miles Per Ton of Coal 2-8-0 Type.	Ton-Miles Per Ton of Coal 2-6-6-2 Type.	Per cent. in favor of Mallet as compared with consolidations.
12.5	16,219.5	26,610	63.9
15.0	14,807.5	23,872	61.2
17.5	....	23,148	....
21.0	14,898	......	....

This run made clear the advantages of this system of compounding for use on divisions which have short grades not sufficient in importance to warrant pusher service, but which nevertheless reduces the train tonnage considerably. Having 20 per cent. increase in power available for short distances, it is evident that the tonnage over such a division could be very materially increased.



THE TRAIN WAS MOVING FROM RIGHT TO LEFT ON THIS CHART WHICH IS A CONTINUATION OF THE ONE ON THE OPPOSITE PAGE.
[One-quarter inch drawbar pull is equivalent to 7,850 pounds.]

Table 4 gives a comparison of the boiler performance of the locomotive and emphasizes clearly the advantage in fuel economy of a large boiler with ample margin of capacity above the average demands. Probably the most striking results shown in this table is the increase in equivalent evaporation per pound of dry coal, which at 12½ miles per hour is 18.8 per cent., reaching a figure slightly above 10 lbs. The cause of this is shown in the next column giving the equivalent evaporation per sq. ft. of heating surface, where it will be seen the consolidation boiler is necessarily forced much higher. In the column giving the temperature in the smoke box, the effect of the combustion chamber and longer flues is clearly evident, there being practically 100 degrees difference, although at 12½ miles per hour the fire box temperature is greater in the consolidation.

The thermal efficiency of the boiler in per cent. tells the story and shows an increase of 17.7 per cent. at 12½ miles per hour; this, of course, is only for the conditions holding during the test where it appears that the consolidation boilers were forced beyond their economical limit although not beyond their capacity, while the Mallet boiler, because of its larger size, superheater and brick arch, was being operated well within its capacity. It

TABLE 4.—COMPARISON OF BOILER PERFORMANCE OF MALLET AND CONSOLIDATION LOCOMOTIVES.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations.
Dry coal fired per hour	12.5	4,033.5	3,680	....
	15.0	4,420.5	4,423	....
	17.5	....	3,985	....
	21.0	4,957	.....	....
Equivalent evaporation per hour, lbs.	12.5	33,957.5	36,849	8.5
	15.0	36,807.	41,819	13.6
	17.5	....	36,203	....
	21.0	39,859.5	......	....
Equivalent evaporation per pound dry coal	12.5	8.42	10.01	18.8
	15.0	8.32	9.45	13.58
	17.5	....	9.08	....
	21.0	8.04	....	....
Equivalent evaporation per hour per sq. ft. of heating surface, lbs.	12.5	10.15	9.32	....
	15.0	11.008	10.58	....
	17.5	......	9.16	....
	21.0	11.914	....	....
Coal fired per sq. ft. grate per hour for time throttle was open	12.5	72.34	65.13	....
	15.0	79.26	78.28	....
	17.5	.....	70.54	....
	21.0	88.91	.....	....
Boiler horsepower	12.5	984.25	1,069.1	8.6
	15.0	1,066.9	1,212.1	13.6
	17.5	....	1,049.4	....
	21.0	1,155.35	....	....
Temperature in smokebox	12.5	616.	519.	....
	15.0	633.	522.9	....
	17.5	....	495.2	....
	21.0	633.5	.....	....
Temperature in firebox	12.5	1,805.5	1,742	....
	15.0	1,783.5	1,936	....
	17.5	....	1,785	....
	21.0	1,868	.....	....
Thermal efficiency of boiler, per cent.	12.5	58.68	69.07	17.7
	15.0	58.63	66.62	13.62
	17.5	.....	68.60	....
	21.0	57.51	.....	....

is to be noted, however, that the relation of the most economical point of a boiler equipped with a superheater much more nearly coincides with its point of maximum capacity than in the case of the saturated steam boiler. The harder a boiler is forced the more economy the superheater will show.

In Table 5 one of the most striking features is the increased machine efficiency shown by the Mallet. The figures were afterwards verified by a test wherein both locomotives were hauled by an electric locomotive, and the only explanation offered is that this is due to the reduction of the unit weight of the moving parts and the shorter rigid wheel base. In this table it will be noted that the column giving the dry coal per dynamometer horse-power per hour shows an economy of 34.4 per cent. minimum and 39.8 per cent. maximum. This result is, of course, the true measure of the economy in coal consumption of two locomotives since all local conditions such as profile and variations in train loading are eliminated.

It appears that the economy of water is not so great as of coal. This would be expected from the evaporation figures given in Table 4. The thermal efficiency of the locomotive is very good in the case of the Mallet, reaching 5.59 per cent. maximum and in all cases being above 5 per cent.

Taken altogether these tests are most encouraging for the

TABLE 5.—COMPARISON OF PERFORMANCE AS A WHOLE OF MALLET AND CONSOLIDATION LOCOMOTIVES.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations.
Average speed running time, miles per hour	12.5	12.75	12.9	....
	15.0	15.7	15.2	....
	17.5	....	17.5	....
	21.0	21.4	....	....
Average drawbar pull, lbs.	12.5	22,726	34,071	49.9
	15.0	19,883	31,360	56.9
	17.5	......	23,424	....
	21.0	15,930	......	....
Maximum starting drawbar pull, lbs.	....	46,280	66,000 working compound	42.6
			80,000 working simple	72.8
Machine efficiency, per cent.	12.5	88.85	89.21	....
	15.0	86.17	89.16	....
	17.5	.....	86.60	....
	21.0	85.35	.....	....
Machine friction in lbs. of drawbar pull	12.5	3,066.5	4,468	....
	15.0	3,517.	4,083	....
	17.5	......	4,044	....
	21.0	3,288.5	.....	....
Dry coal per dynamometer horsepower per hour, lbs.	12.5	5.235	3.15	39.8
	15.0	5.295	3.47	34.4
	17.5	.....	3.65	....
	21.0	5.465	....	....
Water per dynamometer horsepower, lbs.	12.5	33.465	26.80	22.9
	15.0	33.56	26.83	20.05
	17.5	.....	27.08	....
	21.0	33.685	.....	....
Thermal efficiency of locomotive, per cent.	12.5	3.50	5.59	59.7
	15.0	3.50	5.32	52.0
	17.5	....	5.43	....
	21.0	3.445	....	....

success of the Mallet locomotive under conditions for which it is suitable and especially in connection with its use at the higher speeds. It is unfortunate that the data obtained from the tests made on the original locomotive before it was equipped with superheater and brick arch are not available for publication, as it makes it impossible to determine exactly how much of the success of the locomotive as a whole can be assigned to the superheater.

SAFETY PLAN ON THE BALTIMORE AND OHIO

With a view to promoting safety of travel and protecting its employees from personal injury in the discharge of duty, the Baltimore and Ohio has appointed a safety committee to pursue the matter vigorously through a campaign which is to extend to all branches of the service and over every mile of track operated in the system. The safety committee, which began work November 1st with General Manager Thompson as chairman ex-officio, is composed of general officers of the road. Divisional safety committees have also been appointed, composed of division officials, secretaries of the Railroad Young Men's Christian Association, an employee from each shop to represent shopmen, an engineer to represent enginemen, conductor to represent trainmen and yardmaster to represent yard employees.

Several months ago the Baltimore and Ohio management adopted a number of precautionary measures in its locomotive and repair shops for the protection of its workmen, equipped machinery with guard-rails and covers for exposed parts, and the latest steps for safety is an effort to extend this to all branches of the service.

THE GREAT CORLISS ENGINE, the power feature at the Centennial Exposition in Philadelphia in 1876, afterward removed to the Pullman Company's plant at Pullman, Ill., was sold October 5 to the Oakdale Iron Company, Chicago, for scrap. This engine, although rated at only 1,400 h.p., weighed over 650 tons

MOTOR DRIVE FOR PLANERS

At a recent meeting of the Association of Iron and Steel Electrical Engineers in New York, G. W. Richardson, electrical superintendent, American Bridge Company, Philadelphia, read a paper on motor drives for planers in which he said in part:

A motor to drive a planer reversing with every stroke, from the shortest to the full stroke of the planer table, must be a very slow-speed motor, controlled by automatic controller and requiring dynamic braking to stop the table so that there will not be any counter-electromotive force at the time the applied electromotive force is applied to the armature of the motor at the moment of reversals. This must be so arranged that the dynamic braking relay is off at the moment the applied electromotive force is connected and that the dynamic braking take effect at the moment the applied electromotive force is opened. This is really the success of the direct-connected reversing motor drive to-day on planers.

In our machine-shop we have a 120-in. planer which was driven by a 45-h.p. compound wound constant-speed motor driving through a countershaft to the belt shaft containing the flywheel and belt pulleys. These belts were vertical, and 6 in. wide and 4-ply. They reversed from one pulley to the other in the usual way. At the moment of these reversals the motor would be extremely overloaded. These high peaks of current continually coming on the motor at every reversal caused trouble, and we were always doing some repairs. Over 2 galls. of oil were used per day on the planer. The actual delays to the work due to the conditions probably amounted to at least 25 to 30 per cent. of the time of cutting material.

I was asked to try one of my double-armature motors to see if we could overcome the difficulties we were having with the old drive. I installed one 50-h.p., 220-volt, compound wound double-armature motor on the 120-in. planer on December 1st, 1909, using an automatic controller from one of our mill tables, with the exception that I added some new features, such as dynamic braking, field weakening relays, and no-voltage and overload relays. This outfit has not given us any trouble whatever, except the first few days in getting the controller adjusted. The apparatus uses approximately one pint of oil per day. The planer does not chatter. The full speed of the double-armature motor while cutting is 224 revs. per minute, and the center shaft speed is 128 revs. per minute. The peak load is 100 amperes, approximately 30 h.p., starting torque. The dynamic braking current is approximately 150 amperes. The periphery speed of the armatures while cutting is 896 ft. per minute, and 1,792 ft. per minute on the return stroke of the table. This makes the motor easy to reverse, due to the low centrifugal force of the armatures. The cutting speed is from 20 ft. to 25 ft. per minute, and the return speed is from 20 ft. to 50 ft. per minute.

A reversing motor drive that has been placed on Pond planers is no doubt a good apparatus for this kind of work. They use

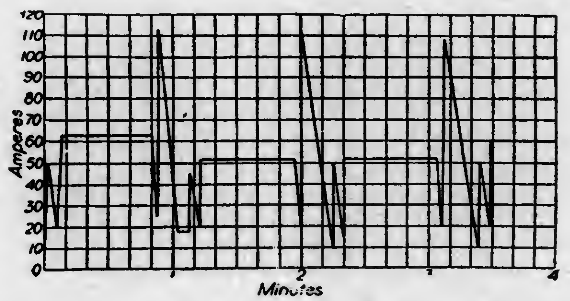


FIG. 1.—CURRENT DEMAND WITH 50-H.P. REVERSING MOTOR ON 8-FT. PLANER.

a single-armature special-made interpole motor, wound 1 to 4 speed, that is, 250 to 1,000 revs. per minute, using dynamic braking for stopping the motor before reversing. The periphery speed of the armature of a 50-h.p. motor for a 96-in. planer is approximately 1,177 ft. per minute to 4,710 ft. per minute. The cutting peak load is 50 amperes, while the reversing peak load is 112 amperes. The cutting speed 12 ft. to 25 ft. per minute, and the reversing speed 12 ft. to [illegible] ft. per minute.

The curve, Fig. 1, shows the ampere load on the 50-h.p. Niles-Bement-Pond Company's reversing motor drive on a 96-in. planer, cutting speed 12½ ft. per minute, return speed 42 ft. per minute, one tool cutting ⅝ in. with ⅛-in. feed, cutting annealed nickel-chrome steel. This curve shows the peak load to start motor was 50 amperes, then, as the speed increased, the time of start to the time of cut was 5 secs. and the current dropped to 20 amperes. Then, as the tool cut into the material the current went up to 62 amperes for 43 secs., then the current was off for 2½ secs. Then, reversing to high speed, the current rose to 112 amperes and the speed kept getting faster until the current was down to 18 amperes, taking about 10 sec. time, then the line continued straight for 5 secs., which was the full return stroke. Then the peak from return to cut rose to 45 amperes and dropped down to 20 amperes for 5 secs. before the tool started the second cut, then the current rose to 51 amperes. The other cuts and reversals were practically the same, except the curve shows that the motor kept getting faster on the return stroke and the current made a practically straight line for 15 secs., the full return stroke. The full field of the motor was approximately 10 amperes.

The curve, Fig. 2, shows our 15-h.p. motor driving a 42-in. Pond planer. This is a two-armature motor, capacity 60 am-

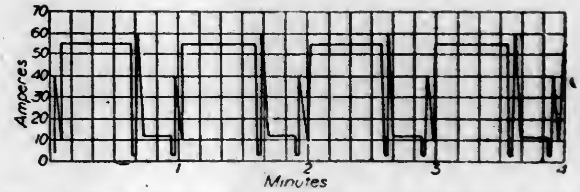


FIG. 2.—CURRENT DEMAND WITH 15-H.P. RICHARDSON MOTOR ON 42-IN. PLANER.

peres. This curve shows that at the time this test was taken the cutting speed was 17 ft. per minute, return speed 44 ft. per minute. Two tools were used, each taking a ½-in. cut and a 3/32-in. feed, cutting cast steel. The shunt field of this motor took 3 amperes. To start required a peak load of 40 amperes, then, as the speed increased, the current dropped to 10 amperes in 3½ secs. before the tool started to cut, then the current rose to 55 amperes for 33 secs.; then the current was off for 1½ secs. when the return peak rose to 60 amperes and the motor got to full speed in 2½ secs. Then the current dropped to 12 amperes for 13½ secs., then the current was off. and so on. This curve shows that the double-armature motor drive gets up to speed quickly with peak loads only to the capacity of the motor. Therefore, the motors run cool and without trouble.

A TRAIN LIGHTING INSTRUCTION CAR

The Pennsylvania Railroad Company has added an unique instruction car to the list of such which various railroads operate for the benefit of their employees, and which is intended to exemplify the various details connected with train lighting. It is a singular fact that although instruction in air brake, through practical demonstration; in combustion and good firing, etc., through lectures, has been widely diffused, the train lighting problem has been practically neglected previous to this innovation.

The Pennsylvania Railroad has at this time no less than eight distinct axle device systems, in addition to the large number of straight storage equipments, and the new car seems to offer the most efficient means of furnishing uniform instructions to yard electricians.

The apparatus installed consists of a 32-cell storage battery; a 15 kw. Curtis turbo-generator; a variable speed motor, with necessary controlling apparatus for driving the axle devices, and the following axle generators with their regulating equipments: Newbold, Moskowitz, Bliss, Consolidated, Safety and Gould. The present intention is that the car will be sent to the different points at which electrical forces are maintained, and the men at such points will be given lectures and demonstrations on the operation and maintenance of these various systems.

With the instruction car in operation it is intended that all employees whose duties have to do with the car lighting shall be instructed in the care and operation of the various equipments, with the two-fold object of educating those interested and securing uniformity in their work.

The More Aluminium an aluminium bronze contains, the softer it is while hot. This is the reverse of hardness of the cold bronzes. While a 10 per cent. aluminium bronze is much harder than a 4 per cent. bronze while cold, it is very much softer while hot, and can be rolled hot much easier.

NEW MIKADO TYPE LOCOMOTIVES

SOUTHERN RAILWAY CO.

With constantly increasing traffic requirements it has been found necessary to introduce heavier power into the freight service of the Southern Railway. Heretofore the heavy freight traffic on this road has been handled by engines of the consolidation, or by those of the ten-wheel type, with the former predominating. The largest of the former, as built by the Baldwin Locomotive Works, have cylinders 22 by 30 in., and 57 inch driving wheels. Saturated steam at 200 pounds pressure is employed, and the total weight is 210,000 lbs., with 188,000 lbs on driving wheels.

These engines, numbered in "600," first appeared on the road in 1904 and were well distributed over the system, but particularly on the Knoxville division where they did very good work and fulfilled every requirement up to a comparatively recent period.

The determination of the management to go into the Mikado type, at least in part, is merely in accord with the popularity which this design now enjoys among a large number of prominent railroads, wheron, in several instances, it has attained supremacy over the consolidation, for the reason, principally, which is well understood, that of increased boiler capacity coupled with the ability to increase the average speed of heavy trains.

MIKADO TYPE LOCOMOTIVE WITH SUPERHEATER.

The new Mikados which have been recently delivered by the Baldwin Locomotive Works to the Southern are a fine example of this type. Thirty-three locomotives were included in the contract, and they have approximately 20 per cent. greater hauling capacity than the consolidations before mentioned. They exert a tractive effort of 51,700 lbs., and with 215,700 lbs. on the driving wheels, the ratio of adhesion is 4.17. These locomotives use highly superheated steam at a pressure of 175 lbs., the superheater being of the Schmidt top header, fire-tube type, with 30 elements, each consisting of a double loop of pipes 1 7/16 in. in diameter.

The boiler used in this design has a long tapered ring in the middle of the barrel, the diameter being 76 inches at the front end and 83 inches at the dome ring. The dome is of pressed steel, 3/4 in. thick, and the longitudinal seam on the dome ring is welded throughout its length, on either side of the dome opening. The firebox is built with vertical side water legs, and the staybolts include 674 of the flexible type. These latter stay the entire throat sheet, and are used in the three outside rows in the back head. In the sides they are located in the six upper horizontal rows, and in the four vertical rows at each end. The grate is practically the same size as that used on the consolidation engines, and in this connection the point has not been lost sight of to retain the interchangeability of many castings. The ash pan is constructed with a continuous slope front to back, and has a damper at the back end, through which the ashes can be discharged by a blower located in the front end of the pan.

The frames are of the most substantial design and construction, both main and rear sections being vanadium steel castings of ample section. The main frames are 5 in. wide, and have a depth of 6½ in. over the pedestals, while the rear sections are 4½ in. wide. Each main frame is in one piece with a single front rail, which has a depth of 13 in. under the cylinder saddle. The pedestal binder bolts are inserted from below, and each bolt has a shoulder which fits into a counterbore in the lower frame rail. The bolt has a taper fit in the frame and a straight fit in the pedestal binder. A single nut is used on the top and two nuts with a cotter on the bottom.

The transverse frame braces include deep steel castings at the second and third pairs of driving pedestals. A similar casting is placed under the front end of the firebox, immediately ahead of the splice between the main and rear frames. The bottom frame rails are braced just back of the first driving pedestals; while the guide yoke, which is of cast steel, constitutes a strong transverse brace, with bearings 24¼ in. long on each frame. The rear bumper consists of two 10 in. channels placed back to back. The spring rigging calls for no special comment, other than the novelty of the equalizer of the trailer being guided in a pedestal in the rear frame section. The trailer is of the Hodges type, which has been extensively used on rear truck locomotives built at the Baldwin Works.

The steam distribution is controlled by 14 in. piston valves, driven by the Walschaert motion. In the present case the link and reverse shaft bearings are supported on the guide yoke; and the reverse shaft has a downwardly extended arm, to which the reach rod is attached. Extension rods are used on the valves and pistons.

The tender is built in accordance with Southern Ry. practice, and has a frame composed of 12 in. steel channels with oak bumpers. The tank carries 8,000 gallons of water and 14 tons of coal. Similar locomotives are being built for the Mobile and Ohio, the Virginia & Southwestern, and the Cincinnati, New Orleans & Texas Pacific railways.

The principal dimensions are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	51,700 lbs.
Weight in working order	272,940 lbs.
Weight on drivers	215,700 lbs.
Weight on leading truck	22,860 lbs.
Weight on trailing truck	34,380 lbs.
Weight of engine and tender in working order	420,000 lbs.
Wheel base, driving	16 ft. 6 in.

Wheel base, total	34 ft. 9 in.
Wheel base, engine and tender	67 ft. ¾ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.17
Total weight ÷ tractive effort	5.08
Tractive effort × diam. drivers ÷ heating surface*	730.00
Total heating surface* ÷ grate area	83.54
Firebox heating surface ÷ total heating surface* per cent	4.5
Weight on drivers ÷ total heating surface*	4.82
Total weight ÷ total heating surface*	61.29
CYLINDERS.	
Kind	Simple
Diameter and stroke	27 x 30 in.
VALVES.	
Kind	Balanced piston
Diameter	14 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Wagon top
Working pressure	175 lbs.
Outside diameter of first ring	76 in.
Firebox, length and width	107⅛ x 71¾ in.
Firebox plates, thickness	S. ⅜ in., B. ⅜ in., C. ⅜ in., T. ½ in.
Firebox water space	F. S. & B. 5 in.
Tubes, number and outside diameter	30—5½, 183—2¼ in.
Tubes, length	20 ft.
Heating surface, tubes	3,007 sq. ft.
Heating surface, firebox	191 sq. ft.
Heating surface, total	3,198 sq. ft.
Superheater heating surface	837 sq. ft.
Grate area	53.3 sq. ft.
TENDER.	
Frame	Steel channels
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	14 tons

* Equivalent heating surface = 4,454 sq. ft.

MAINTENANCE AND OPERATION OF LOCOMOTIVE SUPERHEATER

The Locomotive Superheater Company* has compiled some very interesting information concerning the care and operation of the Schmidt superheater which is considered of sufficient practical value to abstract as follows:

The front end should be carefully inspected every month and the deflecting plate in front of superheater is to be removed for this purpose. The inspection should cover examination for air and steam leaks in front end, for any accumulation of cinders and ashes or deposits on return bends in boiler flues. All air and steam leaks should be stopped. In the case of steam leaks between the header and the superheater units, joints should be immediately tightened, if necessary regrinding ball joints or applying a new gasket to flat joints. When a gasket is applied the joint should be tightened again after the gasket has been under steam pressure the first time.

For the flat joint gaskets we recommend the metal-asbestos gaskets of the Goetze-Gasket and Packing Company, of New Brunswick, N. J. This gasket should be kept in stock where used.

The flues can be easily inspected from the front while a light is held at the firebox end. At regular intervals the boiler flues should be blown out, the same as the boiler tubes are blown out, and thoroughly cleaned of all ashes, cinders and soot. At the same time any deposit which may have accumulated on the return bends nearest the firebox should be broken off and removed. For cleaning the flues the use of air of at least 100 lbs. pressure is recommended in preference to steam or water. It should be applied through a one-half inch gas pipe, which is inserted at the back end of the flue and gradually worked forward under the superheater unit, blowing the dirt out of the front end of the flue. In case steam is used instead of air for blowing out the flues the boiler should be under steam pressure to avoid the condensation of water in the flue, as it would be liable to mix with the ashes, etc., and form a coating on the inside of the large flues. The superheater damper should be open in all cases while cleaning flues.

Every two months the superheater and the steam pipes should be tested with warm water of about 100 lbs. pressure to make sure that all joints, etc., are tight in front end. The return bends at firebox ends should be examined from firebox end at this test.

In setting the flues the prosser should be used and the use of the prosser in preference to the roller is recommended whenever possible in working over the boiler flues. The prosser should have not less than twelve sections, and the rollers not less than five rolls. Inserting plugs in the regular tubes surrounding boiler flues when using roller has proved good practice.

The superheater damper and rigging should work freely, and the damper should be wide open when the throttle is open and there is steam in the damper cylinder. With no steam in damper cylinder the damper should be closed.

The safe ending of boiler flues, when such action becomes necessary, should be done at the firebox end of the flue. The diameter of the boiler flue at this point is 4½ in. outside diameter, the flue having been swaged down from its nominal size to this figure. The method of safe ending should be, in general principle, the same as the usual practice for the 2 in. or 2¼ in. boiler flues. The increased diameter and size of the flue will, of course, require larger machinery for performing this operation.

When the engine is in for general repairs the superheater parts should be carefully cleaned, examined and any defective parts repaired or replaced. The ball joints should be reground and joint should show a good continuous bearing all round the ball. With the flat gasket type of joint between header and superheater units the flange on the unit should come up parallel to the face of header so that the gasket has only to make the joint and does not have to take care of any angle between the flange and header. In replacing the superheater units it is essential that they be properly located in the top of the flue to prevent obstruction to the flow of gases through the flue.

In locating the superheater header, its face for superheater unit joints should be square with the tube sheet, parallel to the top row of flues and at the correct distance above them to insure correct position of the superheater unit in the flue. It should be firmly supported at the ends by header supports. These supports should be correctly located, after header has been placed in its proper position, and securely fastened to the shell of the boiler before the superheater units are put in place. The joint between the header and dry pipe should have a loose ball point ring with the flat face on the header in order to permit of free adjustment of the header.

In storing engines equipped with superheaters, especially where liable to freeze, it is essential that the superheater be thoroughly blown out.

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BLACKSMITHS TO MEET IN CHICAGO.—The executive committee of the International Railroad Master Blacksmiths' Association and President Hoeffle of the organization met in Chicago in October and arranged for the next convention place. Chicago was chosen as place of meeting and the Hotel Sherman was selected as the official headquarters. The convention is to be held on the third Tuesday of August, 1912. The new executive committee is as follows: J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman; George Hartline, L. S. & M. S., Collinwood, O.; Wm. Mayer, Michigan Central, Detroit, Mich.; J. S. Sullivan, Pennsylvania Lines, Columbus, O., and W. C. Scofield, Illinois Central, Chicago.

THE WINTER MEETING OF THE ASSOCIATION OF TRANSPORTATION and Car Accounting Officers will be held at the Seelbach Hotel, Louisville, Ky., 10 A. M., December 12-13, 1911. Reports of the following Committees will be considered: Executive Committee, Committee on Car Service, Committee on Office Methods and Accounting, Committee on Handling Railroad Business Mail, Committee on Conducting Freight Transportation, Committee on Conducting Passenger Transportation, Committee on Joint Interchange and Inspection Bureaus.

AT A MEETING OF THE EXECUTIVE COMMITTEE of the Master Boiler Makers' Association, held at the Fort Pitt Hotel in Pittsburgh, Saturday, October 28th, it was unanimously decided to hold the Sixth Annual Convention of this Association in Pittsburgh, May 14th to 17th, inclusive, 1912—headquarters being at the Fort Pitt Hotel. George N. Riley, of the National Tube Company, was made Chairman of the General Committee of Arrangements, and J. Rogers Flannery, of the Flannery Bolt Company, Secretary and Treasurer of such Committee.

THE CUNARD LINER "AQUITANIA" when completed will be 865 feet long, exceeding the present largest steamship, the *Olympic*, by 12 feet 6 inches.

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SOUTHERN RAILWAY CO.

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These engines, numbered in "600," first appeared on the road in 1904 and were well distributed over the system, but particularly on the Knoxville division where they did very good work and fulfilled every requirement up to a comparatively recent period. The determination of the management to go into the Mikado type, at least in part, is merely in accord with the popularity which this design now enjoys among a large number of prominent railroads, whereon, in several instances, it has attained supremacy over the consolidation, for the reason, principally, which is well understood, that of increased boiler capacity coupled with the ability to increase the average speed of heavy trains.

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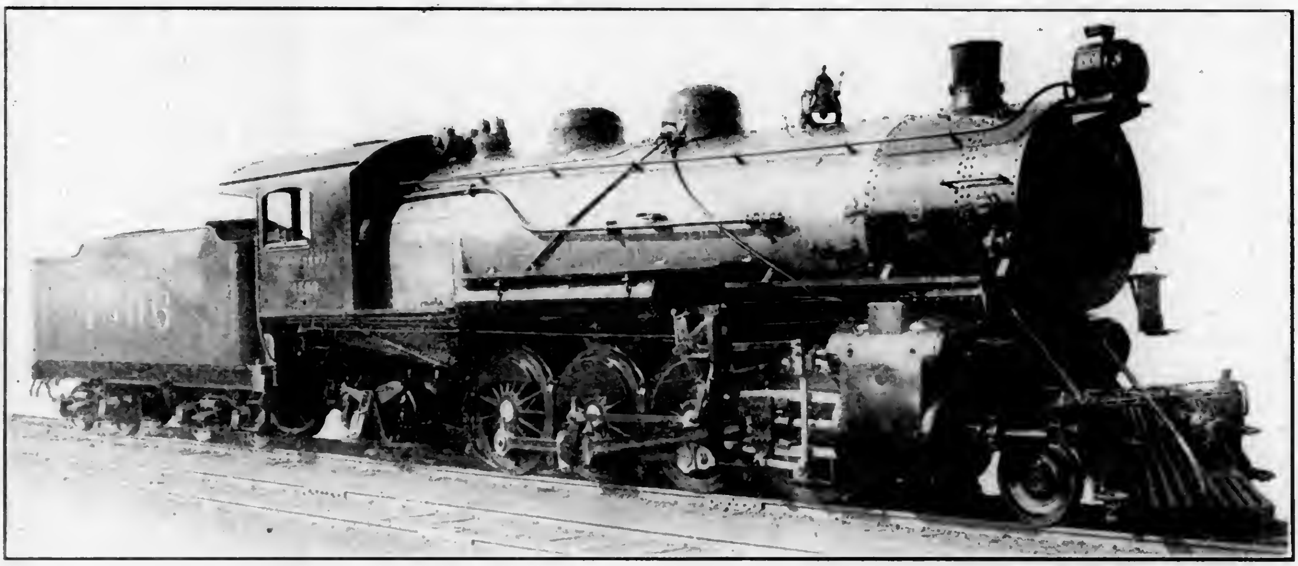
The boiler used in this design has a long tapered ring in the middle of the barrel, the diameter being 70 inches at the front end and 83 inches at the dome ring. The dome is of pressed steel, 5/8 in. thick, and the longitudinal seam on the dome ring is welded throughout its length, on either side of the dome opening. The firebox is built with vertical side water legs, and the staybolts include 674 of the flexible type. These latter stay the entire throat sheet, and are used in the three outside rows in the back head. In the sides they are located in the six upper horizontal rows, and in the four vertical rows at each end. The grate is practically the same size as that used on the consolidation engines, and in this connection the point has not been lost sight of to retain the interchangeability of many castings. The ash pan is constructed with a continuous slope front to back, and has a damper at the back end, through which the ashes can be discharged by a blower located in the front end of the pan.

The frames are of the most substantial design and construction, both main and rear sections being vanadium steel castings of ample section. The main frames are 5 in. wide, and have a depth of 6½ in. over the pedestals, while the rear sections are 4½ in. wide. Each main frame is in one piece with a single front rail, which has a depth of 13 in. under the cylinder saddle. The pedestal binder bolts are inserted from below, and each bolt has a shoulder which fits into a counterbore in the lower frame rail. The bolt has a taper fit in the frame and a straight fit in the pedestal binder. A single nut is used on the top and two nuts with a cotter on the bottom.

The transverse frame braces include deep steel castings at the second and third pairs of driving pedestals. A similar casting is placed under the front end of the firebox, immediately ahead of the splice between the main and rear frames. The bottom



MIKADO TYPE LOCOMOTIVE WITH SUPERHEATER.

frame rails are braced just back of the first driving pedestals; while the guide yoke, which is of cast steel, constitutes a strong transverse brace, with bearings 24½ in. long on each frame. The rear bumper consists of two 10 in. channels placed back to back. The spring rigging calls for no special comment, other than the novelty of the equalizer of the trailer being guided in a pedestal in the rear frame section. The trailer is of the Hodges type, which has been extensively used on rear truck locomotives built at the Baldwin Works.

The steam distribution is controlled by 14 in. piston valves, driven by the Walschaert motion. In the present case the link and reverse shaft bearings are supported on the guide yoke; and the reverse shaft has a downwardly extended arm, to which the reach rod is attached. Extension rods are used on the valves and pistons.

The tender is built in accordance with Southern Ry. practice, and has a frame composed of 12 in. steel channels with oak bumpers. The tank carries 8,000 gallons of water and 14 tons of coal. Similar locomotives are being built for the Mobile and Ohio, the Virginia & Southwestern, and the Cincinnati, New Orleans & Texas Pacific railways.

The principal dimensions are as follows:

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Fuel	Bit. coal
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Weight of engine and tender in working order	420,000 lbs.
Wheel base, driving	16 ft. 6 in.

Wheel base, total	34 ft. 9 in.
Wheel base, engine and tender	67 ft. 3/4 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.17
Total weight ÷ tractive effort	5.08
Tractive effort × diam. drivers ÷ heating surface*	730.00
Total heating surface* ÷ grate area	83.51
Firebox heating surface ÷ total heating surface* per cent	4.5
Weight on drivers ÷ total heating surface*	4.82
Total weight ÷ total heating surface*	61.29
CYLINDERS.	
Kind	Simple
Diameter and stroke	27 x 30 in.
VALVES.	
Kind	Balanced piston
Diameter	14 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3 1/2 in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8 x 14 in.
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Style	Wagon top
Working pressure	175 lbs.
Outside diameter of first ring	76 in.
Firebox, length and width	107 1/8 x 71 1/4 in.
Firebox plates, thickness	S. 3/8 in., B. 3/8 in., C. 3/8 in., T. 1/2 in.
Firebox water space	F. S. & B. 5 in.
Tubes, number and outside diameter	30—5 3/8, 183—2 1/4 in.
Tubes, length	20 ft.
Heating surface, tubes	3,007 sq. ft.
Heating surface, firebox	191 sq. ft.
Heating surface, total	3,198 sq. ft.
Superheater heating surface	837 sq. ft.
Grate area	53.3 sq. ft.
TENDER.	
Frame	Steel channels
Wheels, diameter	33 in.
Journals, diameter and length	5 1/2 x 10 in.
Water capacity	8,000 gals.
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The safe ending of boiler flues, when such action becomes necessary, should be done at the firebox end of the flue. The diameter of the boiler flue at this point is 4½ in. outside diameter, the flue having been swaged down from its nominal size to this figure. The method of safe ending should be, in general principle, the same as the usual practice for the 2 in. or 2¼ in. boiler flues. The increased diameter and size of the flue will, of course, require larger machinery for performing this operation.

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BLACKSMITHS TO MEET IN CHICAGO.—The executive committee of the International Railroad Master Blacksmiths' Association and President Hoeffle of the organization met in Chicago in October and arranged for the next convention place. Chicago was chosen as place of meeting and the Hotel Sherman was selected as the official headquarters. The convention is to be held on the third Tuesday of August, 1912. The new executive committee is as follows: J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman; George Hartline, L. S. & M. S., Collinwood, O.; Wm. Mayer, Michigan Central, Detroit, Mich.; J. S. Sullivan, Pennsylvania Lines, Columbus, O., and W. C. Scofield, Illinois Central, Chicago.

THE WINTER MEETING OF THE ASSOCIATION OF TRANSPORTATION and Car Accounting Officers will be held at the Seelbach Hotel, Louisville, Ky., 10 A. M., December 12-13, 1911. Reports of the following Committees will be considered: Executive Committee, Committee on Car Service, Committee on Office Methods and Accounting, Committee on Handling Railroad Business Mail, Committee on Conducting Freight Transportation, Committee on Conducting Passenger Transportation, Committee on Joint Interchange and Inspection Bureaus.

AT A MEETING OF THE EXECUTIVE COMMITTEE of the Master Boiler Makers' Association, held at the Fort Pitt Hotel in Pittsburgh, Saturday, October 28th, it was unanimously decided to hold the Sixth Annual Convention of this Association in Pittsburgh, May 14th to 17th, inclusive, 1912—headquarters being at the Fort Pitt Hotel. George N. Riley, of the National Tube Company, was made Chairman of the General Committee of Arrangements, and J. Rogers Flannery, of the Flannery Bolt Company, Secretary and Treasurer of such Committee.

THE CUNARD LINER "AQUITANIA" when completed will be 865 feet long, exceeding the present largest steamship, the *Olympic*, by 12 feet 6 inches.

[ESTABLISHED 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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DECEMBER, 1911

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TO SUBSCRIBERS—The **American Engineer and Railroad Journal** is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper should at once notify the postmaster at the office of delivery, and in case the paper is not then received this office should be notified, and the missing copy will be supplied.

CONTENTS

ANNOUNCEMENT

THE AMERICAN ENGINEER AND RAILROAD JOURNAL has been purchased by the publisher of the *Railway Age Gazette* and will be continued as an independent publication. It is believed that by this change in management the paper will be greatly strengthened in many important particulars and be able to accomplish its purpose in a more effective manner.

Beginning with the January issue, there will be included in these pages the Shop Section of the *Railway Age Gazette*, which has heretofore formed part of the first issue in each month of that journal. This department will be appreciated by our readers and, taken in connection with other improvements, will undoubtedly meet with the hearty approval of both subscribers and advertisers.

The *Railway Age Gazette*, through its Shop Section, has done much to advance economy and efficiency in railway shop practice. By transferring this work to THE AMERICAN ENGINEER it will be free to devote more space to other important problems which are not only of vital interest to mechanical department officers, but also to those concerned in financing and operating railways. While this will make it necessary for most of the mechanical department officers to take both papers to keep abreast of the times, there is no doubt but what they will be amply repaid.

ECONOMY VS. CAPACITY

Much is heard about this device saving 10 per cent., that one 14 per cent. and the other 30 per cent. in fuel, cost of repairs, etc., and accurate tests are produced to show the validity of the claims. There is no doubt but what these results are correct and reliable, but is this saving in fuel or repairs the vital feature which will determine the use of the different appliances or designs? It is the desire of a railway company to transport loaded cars from one point to another at the lowest cost per ton-mile consistent with good service. It is well known that this in most cases can be attained best by the heaviest trains operated at a fair speed, and while no one has any objections to saving 5 tons of coal per trip, the general balance sheet will be improved more by hauling 5 extra cars per trip.

While, of course, there are some locomotives operating below 100 per cent. capacity, which will not show results in this way, they are probably too few to be worthy of consideration and in most cases the capacity is so frequently exceeded that the item of over-time becomes serious. What is really wanted by railways from new locomotive designs, superheaters, brick arches, stokers, etc., is more ton-miles per hour over the division, more cars hauled at the same speed or the usual train hauled at a higher speed, and the value of these improvements to a railway company in a great majority of cases lies in their qualities as capacity increases and not as fuel savers. It is not that so many less tons of coal are burned, but that so many more cars are hauled per ton that counts.

In the tests on the New York Central Lines, which are given in this issue, very gratifying economies are shown by the Mallets over the consolidations, and while these are very pleasing, the fact that 1,400 cars can be transported over the division in 24 hours where previously 1,000 cars was the maximum, is the one that dictated the adoption of this type of locomotive.

In this connection the recent experience of a certain railway is interesting and instructive. The company applied to some of its locomotives a device which from thoroughly reliable trials on other roads could be expected to give an economy or increased capacity of about 10 per cent. After thoroughly practical road tests covering a considerable period it was reported that the device showed an economy of 35 per cent. in coal consumption under the same conditions as other locomotives not so equipped. Unquestionable figures were presented by the company's local officials verifying these results.

This was so surprising that a detailed investigation was made by those interested and it was found that while the device in itself was giving about the expected economy, the remaining 25 per cent. was obtained by simple changes in the arrangement and adjustment of the locomotive which has been recommended by the expert applying the device.

This is by no means an unusual occurrence and explains to some extent why some appliances do not give as good results on some roads as on others where conditions seem to be very similar. Beyond doubt there are many locomotives now in use

which are burning from 15 to 25 per cent. more fuel than is necessary for the work they do or are doing from 25 to 30 per cent. less work than they are capable of.

How many master mechanics are sure that there is a sufficient air opening into the ash pan of their locomotives? How many know that the most economical relation of valve setting and size of exhaust nozzle are being used? How many have experimented to find the best design of grate bars for the particular power on their division? How many are sure they have the best relation of stack and size and shape of exhaust nozzle?

These things and many other similar comparatively simple changes will make a great difference in the capacity of the locomotive and it should not be left for the experts of the supply companies to inform the motive power man on his own business.

THE PHILOSOPHY OF ENGINE FAILURES

A recent paper read before the Northern Railway Club, which is briefly reviewed elsewhere in this issue, infuses new life in the old question of engine failures, the bugbear of motive power departments generally, and the true worm which never dies. Nothing of particular value was evolved from this discussion, because it proceeded in accordance with the conventional lines whereupon each of the several departments cast its blame elsewhere while individually excusing themselves. The entire proposition simply resolves into a confirmation of what all of us with actual experience have known long ago, that the general plan employed in dealing with this objectional but none the less inseparable feature of railroad operation is unquestionably unfair, and with the mechanical department always in the star role as the scapegoat.

This latter statement is not intended to imply that this department is intentionally placed in this position by its more influential collaborator in the general scheme, or, in other words, that of transportation or operating, but adherence to time-honored procedure naturally brings this about. When a mishap does occur in connection with the locomotive while on the road it is not reported by the engineer to the master mechanic, but by the conductor to the superintendent or train despatcher. In a great number of instances the conductor endeavors to obtain the real facts, but in many others he fails to do so, either through lack of the energy required to walk up to the head end of the train, or through a lack of realization of what the importance of a true report means to the motive power department, which will eventually receive it *via* that of the operating.

In consequence the reports which appear on the daily engine failure sheet sent by the superintendent to the master mechanic such information is often entirely misleading, and results in prolonged correspondence over an incident which may have never occurred, or, if it did, nothing in extent or gravity to that given the dispatcher.

The manifest unfairness of the procedure as ordinarily employed may be attested to through the following instance: A passenger train was delayed at a certain point by what was nothing more than a slow working train crew. In the meantime the engineer, who had observed before leaving the initial point of the run that a pipe clamp was loose under the running board, concluded that it might be to the point, in view that there was nothing else to do but wait on the conductor, to tighten it up. About the time, however, that he put his wrench on the nut the train crew had completed their work and were ready to start, but the conductor, observing the engineer to be at this tinkering, and knowing himself to be four minutes late through his own slow work, delayed giving the starting signal until the engineer had leisurely completed repairs which might as well have been entirely omitted as not.

In consequence the conductor wired, "Delayed six minutes account of engineer working on engine," and thus it so appeared on the engine failure sheet the next day. The fact that the engineer took occasion at that particular time to repair a trifling defect placed the conductor in a position to ascribe the entire delay thereto, and naturally, knowing himself to be at fault, was quick to take advantage of it.

In the subsequent explanation which the master mechanic was, of course, called upon to make, he could not dispute that the clamp was tightened, and he was not in a position to go into sufficient detail to demonstrate that it was practically unnecessary work. Hence an engine failure was recorded against his division, and incidentally a black mark against the entire motive power department.

This is a true incident, and every master mechanic in railroad service can recall its counterpart. They know that it is wrong; that the conductor's statement is untrue, but being so heavily harassed with other matters, they are unable to devote the necessary time to a full investigation which would develop the real facts and expose the prevarication.

A well-remembered incident in connection with such misinformation occurred recently on a prominent New England railroad, which, as further illustrative, is worth repetition. This was at a point where a fast express train was scheduled to stop five minutes for water and to permit a dining car to be removed. Water was taken in three minutes, and so far as the engineer was concerned, he was ready to go. The diner was detached within its stipulated time, and the start might have been made on time had it not been for the fact that the conductor, not expecting such celerity of movement, failed to keep up his own end and was not in a position to pull out.

At this unfortunate psychological moment, for the master mechanic and motive power department the engineer was observed up front giving a parting twist to a main pin grease plug. On observing the signal the runner jumped immediately into the cab and started, as he could have done three minutes before had the conductor been ready, but the latter nevertheless explained the delay by "waiting on the engineer."

Of course, the engineer indignantly explained to the master mechanic the error of the report and the manifest subterfuge of the conductor, but, on this road at least, without avail in eradicating the supposed engine failure from the sheet.

In addition to the above mentioned common instances of where the motive power department gets the worst of it may be cited what frequently transpires on freight trains; that is, when an actual engine failure does occur at a point where considerable work is to be done, all of the delay is assigned to the engine. To illustrate, an engine lost a rod key and ten minutes was spent by the engineer in trimming up a piece of wood to drive into the slot in lieu thereof. In the meantime, however, considerable bungling had resulted on the caboose end of the train in spotting some cars on a wrong siding, making it necessary to extricate them therefrom to the position designated on the way bills. This resulted in a total delay of forty minutes, of which ten should have been charged to the engine and thirty to the train crew, but of course the master mechanic read next morning that train so and so had been detained at X forty minutes by "engineer working on engine."

It is absolutely necessary that railroads follow the question of engine failures with the regard which they do. Practically all have agreed that even a delay of but two minutes to a fast train must be explained, and this is essentially right through the moral effect produced. It needs little consideration to decide how quickly discipline would become relaxed and efficiency impaired without this eternal prodding, but it is particularily unfortunate, as has been before shown, that the reports are too often misleading.

Engines fail, and will fail, as long as the scheme of steam railroading exists, and only eternal vigilance will hold them to the minimum, but the burden of censure following such is not evenly distributed. In the main it should rest upon the motive power end of it, but the latter should have the benefit of all possible doubt. There should absolutely be a check on all conductor's reports, and it will be found that the inauguration of a plan to accomplish this will relieve much of the friction which it cannot be denied exists between the office of master mechanic and that of division superintendent arising from these errors.

FLEXIBLE METALLIC ROOF FOR BOX CARS

With the possible exception of the draft gear and its attachments, there is probably no one part of the box car that is a source of so much trouble and expense as the roof. The conditions to be met by the roof on a box car, particularly on one of all-wood construction that has been in service some time, are very difficult and many different schemes have been proposed to meet them. Some of these have proven to be very sucessful under ordinary conditions, and others, while seeming to be capable of fulfilling the conditions, have not satisfactorily stood the test of practice. Perfect flexibility in all directions is an absolute requisite of a successful box car roof, but combined with this, it must also possess great durability, be capable of successfully withstanding mechanical injury and come within reasonable limits as to weight and cost.

A new type of roof, which it is believed fulfils all of these conditions and has added advantages in connection with an improved attachment for running board and reduced clearances, has been designed by the Franklin Railway Supply Co., 30 Church street, New York City. Roofs of this design have been in service in sufficient quantities and for a sufficient length of time under different conditions to indicate that the expectations of the designers are being fulfilled.

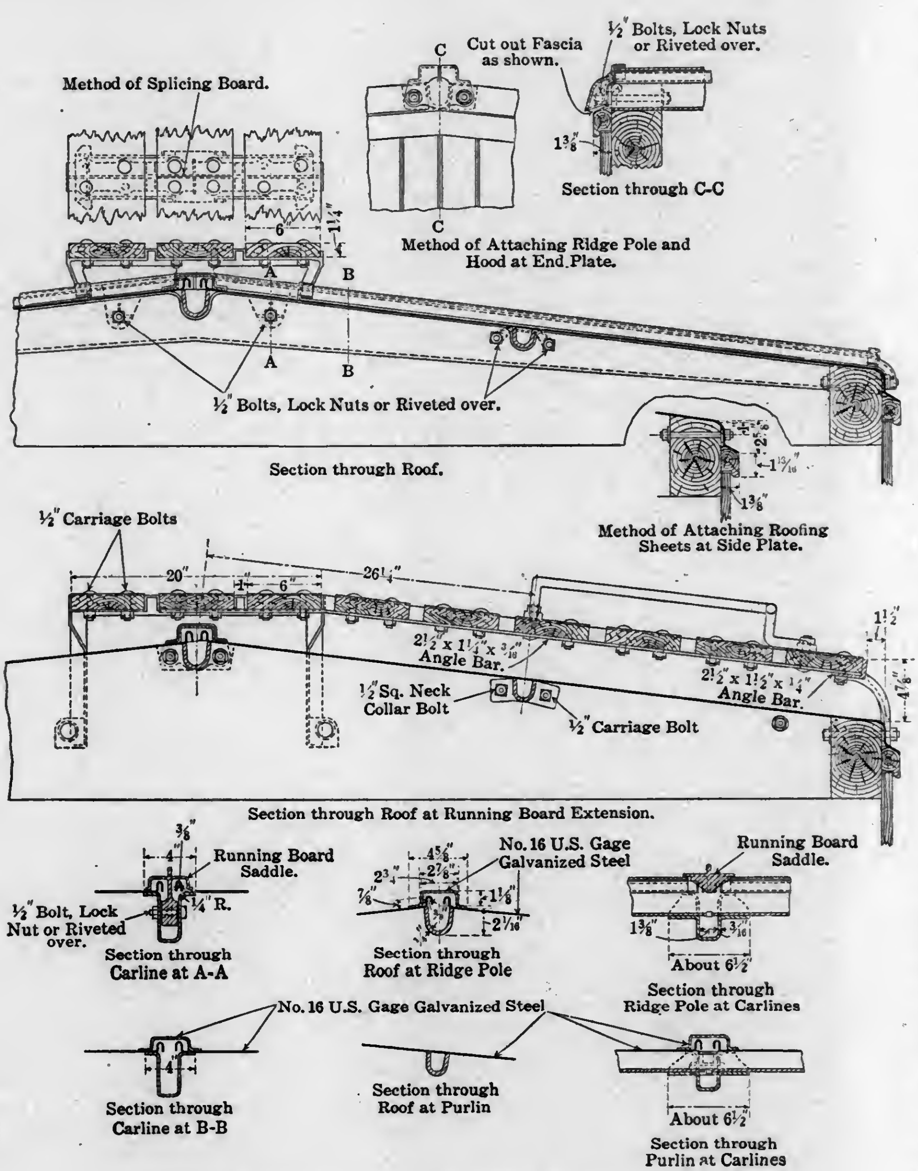
This roof is being furnished in two designs, one comprising the whole roof, including purlines, carlines, ridge pole, running board and all attachments, which is called the all-steel type, and the other, called the outside type, is arranged for application over the present roof, which may have any style or arrangement of members. An essential feature in both designs is that the running board and all weight coming upon it are supported entirely and directly from the carlines. This construction is arranged to fulfil every requirement of the new safety appliance law.

INTERIOR OF CAR FITTED WITH THE ALL-STEEL TYPE OF FRANKLIN FLEXIBLE ROOF.

The general basis of the design is the forming of the roof of a series of independent galvanized steel plates 1/16 inch thick each of a size to cover the area between carlines and from the ridge pole to the side plate. The edges of these sheets at the sides and ends of the car are turned down over the side and end plates. The sides which are adjacent to the carlines and ridge pole have their edges turned up and then turned down, extending slightly below the level of the carlines and ridge pole, as shown in the illustrations. The sheets are secured by bolts at the plates, but are otherwise entirely free to move relative to each other and the adjoining edges of the sheets are separated a sufficient distance to permit this free movement. No attempt is made to form a water-tight joint at these points and the carlines and ridge pole are made in "U" section and arranged to

THIS CLEARLY SHOWS THE REDUCED CLEARANCE AT THE EAVES GIVEN BY THE FRANKLIN FLEXIBLE ROOF

form a gutter for carrying off any water which may work its way up and over the upturned edges of the roofing sheets. Over the gaps between the sheets there is a cap which prevents any direct entrance of water to the joint. This cap, while holding the sheets in place, is not secured to them and does not interfere with their relative movement. It is held in place at its outer end by being inserted in a pocket in the malleable iron carline hood and at the inside end by pockets in the running board saddle. A similar cap over the ridge pole is secured by being inserted in pockets in the running board brackets. The carlines and ridge pole are carried through the side and end plates which are gained to receive them. The ends of the carlines are turned down and they are fastened by two horizontal square-necked collar bolts passing through this downturned projection and the side plates of the car. These same bolts hold the malleable iron carline hood which is arranged to prevent the entrance of dirt and cinders, but to permit the exit of water from the carlines and also hold in place the carline caps as mentioned above. The arrangement at this point is such as to give a minimum car clearance at the eaves. The fascia boards project beyond the ends of the carline and the carline hoods, thus protecting them from being broken by projecting obstacles. Rolled steel bars "U"-shaped in section form the ridge pole and purlines. They pass over the carlines through depressed sections, thus placing their upper edges on the same plane as the top edges of the carlines. A hole is placed at the bottom of the ridge pole and purlines where they intersect the carlines, forming a drain from these members to the carlines. It will be noted that there is no joint between the roof sheets at the purlines and these are made in "U" sections simply for strength. A key is provided securing the purlines to the carlines at each junction, which not only acts as an anchor at that point, but greatly strengthens the structure.



FRANKLIN FLEXIBLE CAR ROOF—ALL-STEEL TYPE.

One of the most interesting and important features of the design is the construction and arrangement of the running board saddles. These are of malleable iron and are arranged for 6-inch boards fastened by carriage bolts. The top horizontal bar is provided with projecting lugs at the ends and between the boards forming a pocket for them to set in and small corner projections are provided which enter the boards at their edges, thus preventing them from shifting endwise. Suitable pockets for receiving the ends of the carline caps are arranged and this casting forms the cap over the joint underneath the running board, similar pockets are also arranged for receiving the ridge caps. From the under side of the saddles extend lugs which fit into the "U"-shaped carline in the all-steel type and are secured by two horizontal bolts. This not only insures that the weight will be transmitted to the carline, but also that there will be a fixed distance between the running board saddle and the carline so that the roof sheets cannot become bound or pinched at this point. From the under side of the saddles there is a web extending down at the center engaging the top edges of the ridge pole, thus holding it in place.

At the ends of the ridge pole there are malleable iron hoods similar to those at the ends of the carline and the ridge pole is turned down over the end plate in the same manner.

Malleable iron brackets carry the running board extensions at the ends of the car. These are arranged with the lip at the outer end coming up flush with the ends of the boards, thus protecting them and preventing any endwise shifting. The running board side extension is carried on angle bars with the vertical leg upward, which are secured by being bolted to the running board and by a malleable iron support at the corner of the car.

With the outside type of roof, the carlines, ridge pole and purlines may be of any kind and the roofing sheets are laid directly upon the roofing boards, but are not secured to them. The construction of the upturned edges is altered somewhat to permit a trough being inserted for performing the same function as the carlines in the all-steel type. The roofing sheets are secured to the side and end plates in same manner as before and the carline and ridge caps are the same style. The running board brackets and saddles are very similar to the all-steel design and are carried through and connected to the carlines in the same general manner, insuring that no weight from this source shall be transmitted to the roofing sheets.

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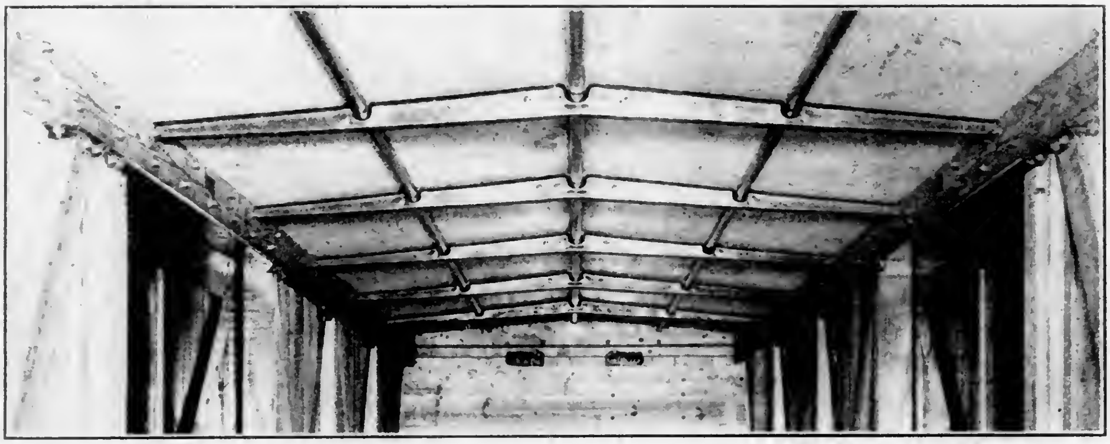

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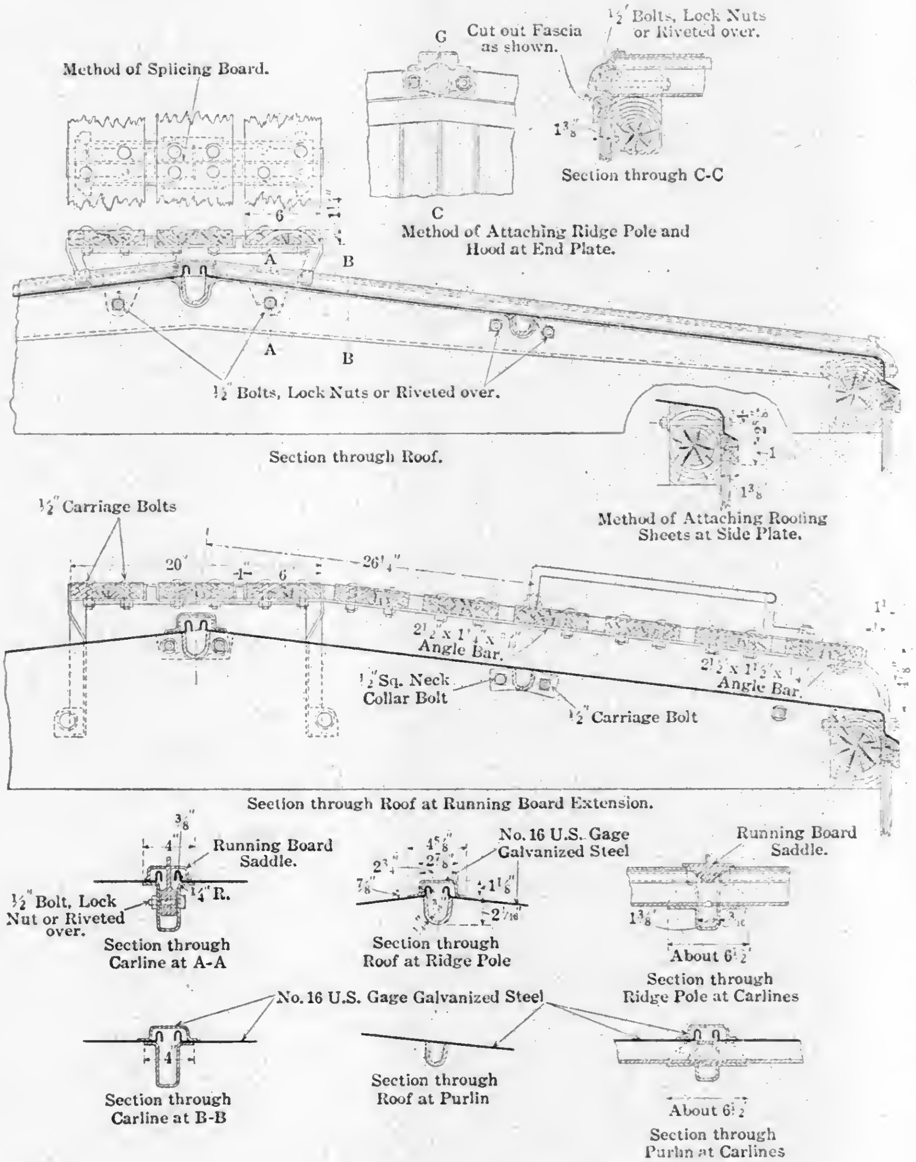

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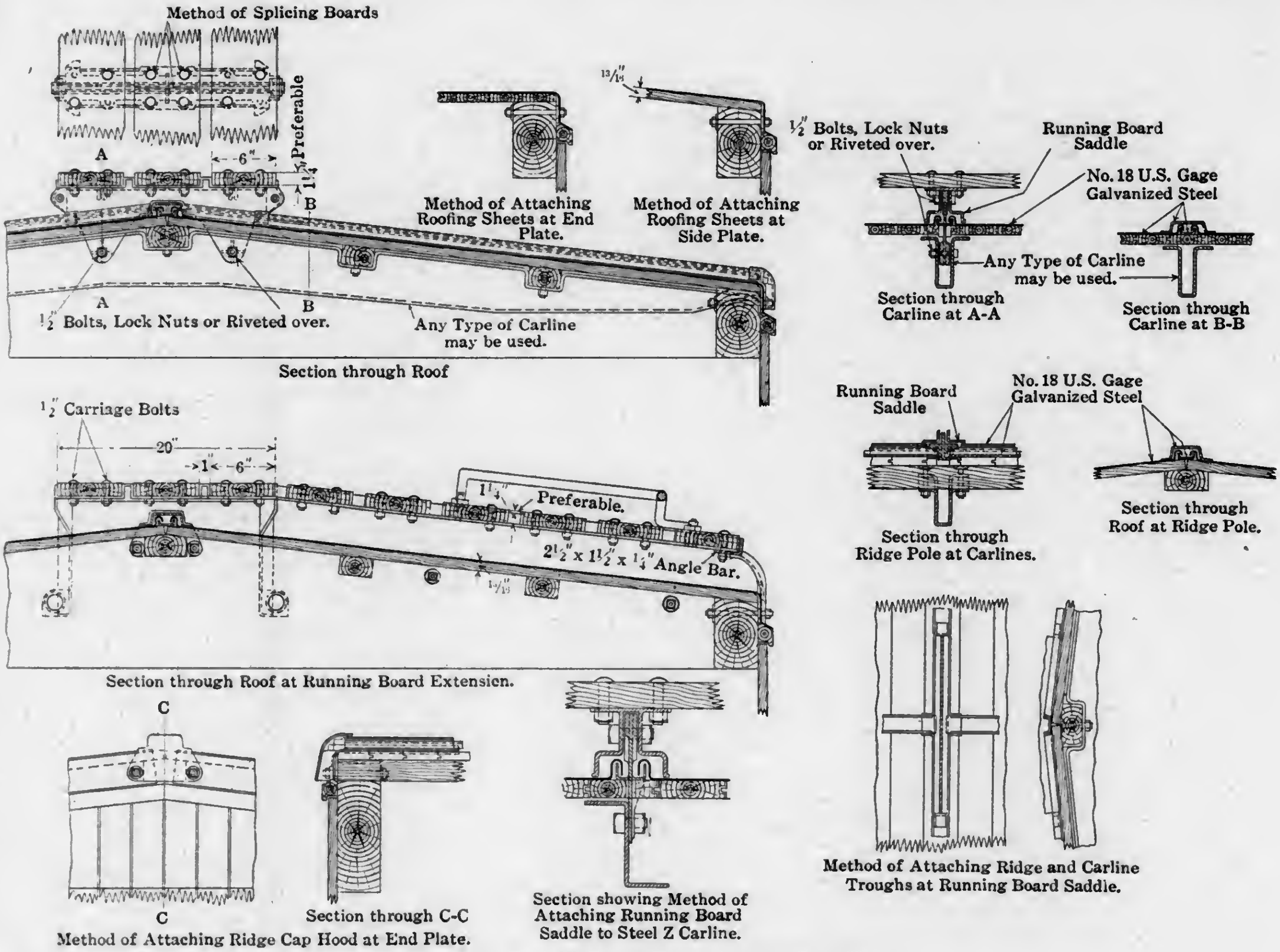
In both cases, all parts of the roof which is exposed to the atmosphere are thoroughly galvanized, and as the air can circulate freely through the carline and ridge caps, no excessive corrosion can occur.

Both of these types can be applied by the usual labor employed on this class of work, and on account of the small number of parts and the method of locking the roof members together, the amount of labor to apply the roof is greatly reduced. The total weight of the all-metal type of roof is about 2,500 lbs., the outside type, of course, being very much lighter.



FRANKLIN FLEXIBLE CAR ROOF—OUTSIDE TYPE.

RECOVERY OF TIN FROM TIN SCRAP, used tin cans, old tin pipe, worn driving-box linings, drosses, old solder, bronze sweepings, etc., in the United States is increasing. From these materials the recovery of tin is commonplace and expected except from used tin cans; in them the loss of tin is enormous. The tin recovered during 1909 as tin amounted to 2,423 tons: in the form of alloys, such as solder, babbitt metal, bronze, etc., 3,092 tons; a total of 5,515 tons, equal to more than one-ninth of the tin imported into the United States and worth $3,281,425. Besides the money value involved, the world's tin resources were increased by so much—a very real conservation.

THE LONGEST METAL SHAVING.—W. B. Duff, a machinist, claims to have broken the world's record by making the longest shaving ever produced. While turning down a piece of vanadium steel, he cut out a spiral sliver that measured 121 feet in length. Shortly after getting this remarkable result, he cut another shaving that measured 155 feet. The best previous record ever reported was from the Santa Fe Railroad shops at Topeka, where a shaving of 110 feet was turned out.

LOCOMOTIVE FIRE FIGHTING APPARATUS

W. R. Barton, fire prevention inspector of the Missouri Pacific-Iron Mountain, has studied out a fire fighting apparatus which can be attached to railroad locomotives and effectively employed in preventing conflagrations near the tracks. A recent test made at the Ewing Avenue shops of the Missouri Pacific in St. Louis was witnessed by the fire chiefs of that city, and their endorsement of the appliance was such that the railroad has decided to equip all yard engines on the entire system with it and also a number of road locomotives.

The tanks of the large yard engines hold 6,000 gallons of water. Barton's plan is to carry 50 ft. of 1¼-inch steam hose on a reel under the running board of the engine. Steam hose is used, as the water which comes from the tank and is forced through the branch pipe is very hot, and in a short time would destroy the ordinary rubber hose. The connection is placed on the branch pipe between the boiler check and injector. The idea is that when an engine reaches the scene of a fire in the yards a switchman is to jerk the hose from the reel and attach it to the coupling leading from the branch pipe, and the engineer is to start the injector, while the fireman goes out on the running board and opens the valve in the branch pipe leading to the boiler check. The stream of water can then be turned on the conflagration.

THE PRESERVATION OF IRON IN CONCRETE is again demonstrated in the demolition of an old gasometer in Hamburg, Germany. This structure was built about 1852, and when taken down forty-eight years later, the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatsoever of rust.

CINCINNATI SLOW SPEED PLANER DRIVE

A very interesting slow speed arrangement as applied by the Cincinnati Planer Co. to a 36-in. machine is clearly shown in the accompanying illustrations. This additional feature is attained through gears in connection with an electric variable speed drive, and was developed through a realization that a slow speed must be employed in machining extremely hard castings. These slow speeds are also quite applicable to work of irregular shape or wide surfaces which are finished by a form tool.

The planer is driven by a 2 to 1 variable speed motor directly coupled to the top shaft, which runs in ring oiled bronze bushed bearings and carries the regular cut and return pulleys (A) and (B) which are keyed to the shaft. The cutting and return speeds are changed by setting the handles shown at (C) and (D) to any predetermined speed. The drive, so far as described, constitutes the regular arrangement, giving cutting speeds of 27 to 54 feet per minute and return speeds of 75 to 150 feet. Any combination of these may also be obtained; for instance, it is possible to run forward on the cutting stroke at 27 ft., and return at 150 ft., or cut at 40 and return at 100 ft. per minute, and again the return may be left set at 100 ft. and only the cutting stroke varied. These changes can be made instantly while the machine is idle or while running on either stroke.

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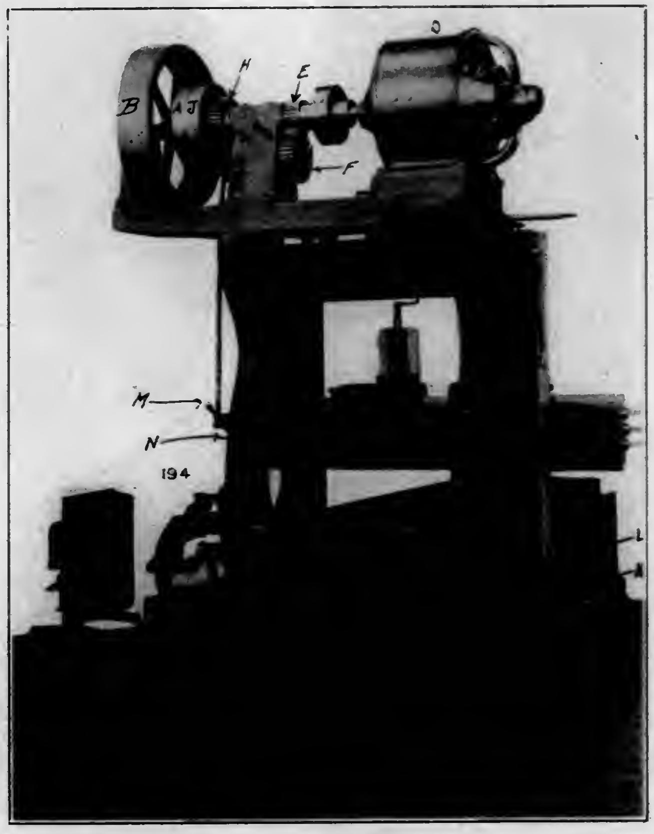
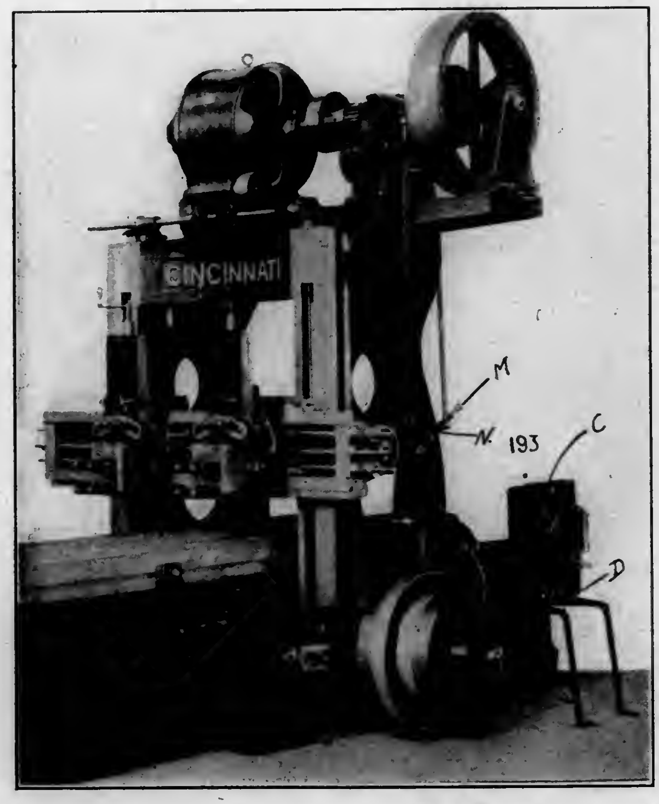
To change this planer from the slow to the regular speeds it is only necessary to disengage the back gear handle (K) and reverse the clutch handle (L). The before mentioned handle (N) then being used to return the belt from pulley (J) to pulley (A). If the planer is going to be used on the regular speeds for any length of time the back gears (F) and (G) may be disengaged, handle (M) being provided for this purpose.

The whole makes a very flexible arrangement, giving cutting speeds of from 1.6 to 3.2 ft., or from 15 to 54 ft. per minute.



REAR VIEW OF PLANER.



CUTTING AND RETURN SPEED ADJUSTMENT.

CALORIZED ELECTRIC SOLDERING IRON

The use of the ordinary soldering iron has two serious drawbacks—the impossibility of keeping it hot continuously, and the rapid wasting away of the copper. The development of the electric soldering iron obviated the former, furnishing the mechanic with an iron which not only stayed uniformly hot all the time, but one in which the heat intensity could be easily regulated by the mere turning on or off of the current. The second fault, that is, the rapid wasting away of the copper, still remained, to a large extent, necessitating frequent renewals, and consequently making no reduction in the cost of maintenance.

It is of much interest to metal workers to know that many experiments made in the research laboratories of the General Electric Company to mitigate this fault has resulted in the discovery of a process of treating the copper which renders the latter non-oxidizable under high heats and non-corrodable by the acids used in soldering. Furthermore, it reduces to a minimum the dissolving action of the molten tin, with which the working tip must always be kept coated. This "calorizing" process or method of treatment does not merely coat the surface of the copper with a thin layer of non-oxidizable or non-corrodable substance, liable to scale off under the effects of heat and acids, but actually changes the characteristics of the copper to an appreciable depth. Thus the durability or practical working life of the copper is increased to such an extent as to provide a soldering iron of maximum economy and effectiveness.

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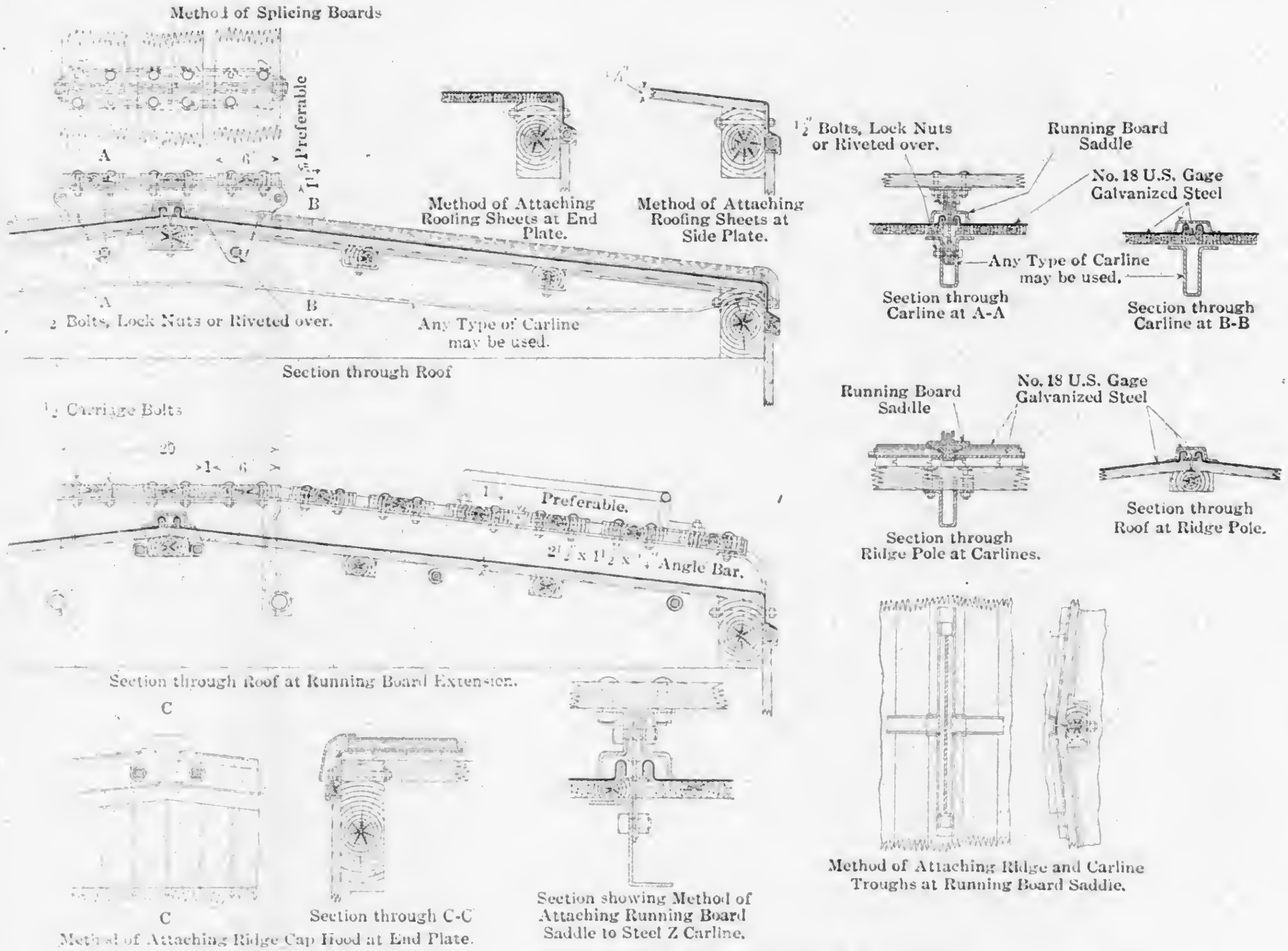
In both cases, all parts of the roof which is exposed to the atmosphere are thoroughly galvanized, and as the air can circulate freely through the carline and ridge caps, no excessive corrosion can occur.

Both of these types can be applied by the usual labor employed in this class of work, and on account of the small number of parts and the method of locking the roof members together, the amount of labor to apply the roof is greatly reduced. The total weight of the all-metal type of roof is about 2,500 lbs., the outside type, of course, being very much lighter.



FRANKLIN FLEXIBLE CAR ROOF—OUTSIDE TYPE.

RECOVERY OF TIN FROM TIN SCRAP, used tin cans, old tin pipe, worn driving-box linings, drosses, old solder, bronze sweepings, etc., in the United States is increasing. From these materials the recovery of tin is commonplace and expected except from used tin cans; in them the loss of tin is enormous. The tin recovered during 1909 as tin amounted to 2,423 tons; in the form of alloys, such as solder, babbitt metal, bronze, etc., 3,092 tons; a total of 5,515 tons, equal to more than one-ninth of the tin imported into the United States and worth $3,281,425. Besides the money value involved, the world's tin resources were increased by so much—a very real conservation.

THE LONGEST METAL SHAVING.—W. B. Duff, a machinist, claims to have broken the world's record by making the longest shaving ever produced. While turning down a piece of vanadium steel, he cut out a spiral sliver that measured 121 feet in length. Shortly after getting this remarkable result, he cut another shaving that measured 155 feet. The best previous record ever reported was from the Santa Fe Railroad shops at Topeka, where a shaving of 110 feet was turned out.

LOCOMOTIVE FIRE FIGHTING APPARATUS

W. R. Barton, fire prevention inspector of the Missouri Pacific-Iron Mountain, has studied out a fire fighting apparatus which can be attached to railroad locomotives and effectively employed in preventing conflagrations near the tracks. A recent test made at the Ewing Avenue shops of the Missouri Pacific in St. Louis was witnessed by the fire chiefs of that city, and their endorsement of the appliance was such that the railroad has decided to equip all yard engines on the entire system with it and also a number of road locomotives.

The tanks of the large yard engines hold 6,000 gallons of water. Barton's plan is to carry 50 ft. of 1¼-inch steam hose on a reel under the running board of the engine. Steam hose is used, as the water which comes from the tank and is forced through the branch pipe is very hot, and in a short time would destroy the ordinary rubber hose. The connection is placed on the branch pipe between the boiler check and injector. The idea is that when an engine reaches the scene of a fire in the yards a switchman is to jerk the hose from the reel and attach it to the coupling leading from the branch pipe, and the engineer is to start the injector, while the fireman goes out on the running board and opens the valve in the branch pipe leading to the boiler check. The stream of water can then be turned on the conflagration.

THE PRESERVATION OF IRON IN CONCRETE is again demonstrated in the demolition of an old gasometer in Hamburg, Germany. This structure was built about 1852, and when taken down forty-eight years later, the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatsoever of rust.

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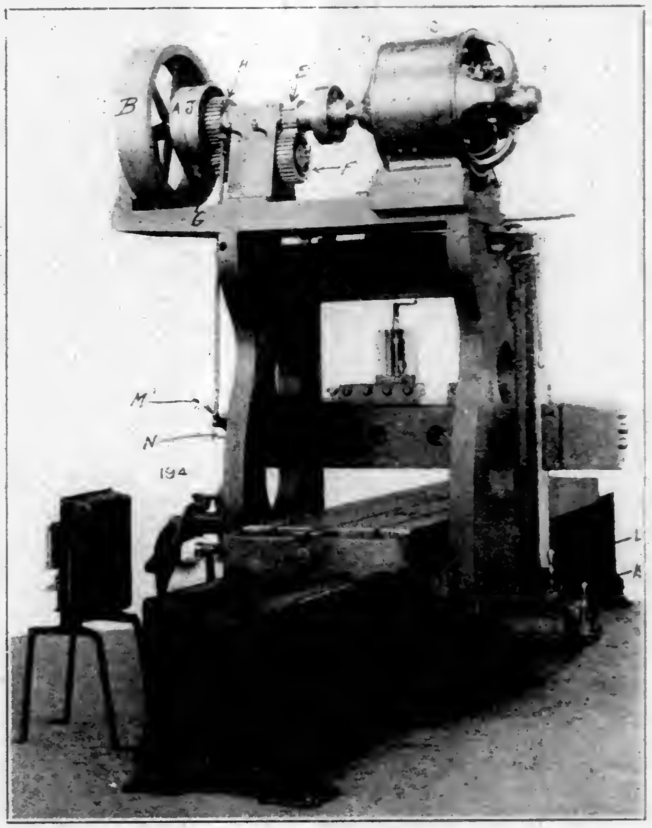
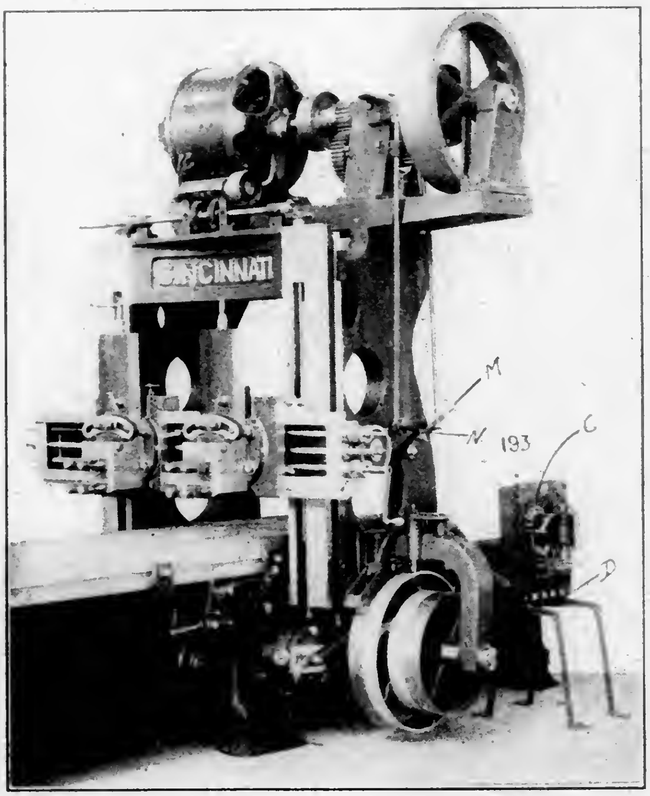


REAR VIEW OF PLANER.



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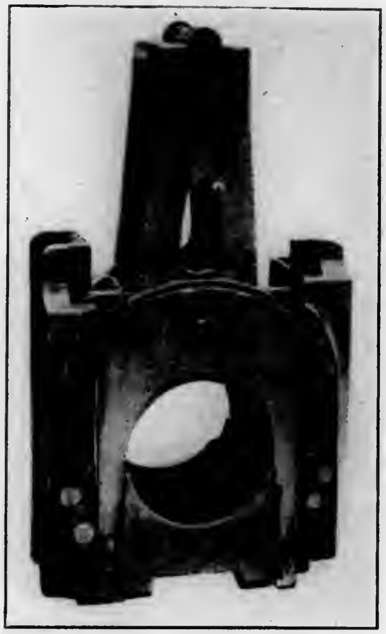
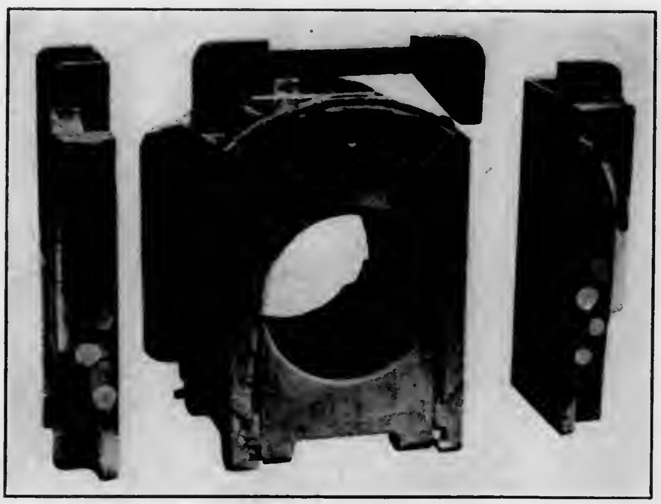
AN INTERESTING SECTIONAL DRIVING BOX

The rapidly increasing size of locomotives with the addition and redesign of the accompanying parts, especially those under the engine, made necessary by new wheel arrangements with underhung spring rigging, and many other details which were unknown only a few years ago, have converted the maintenance of driving boxes into a very serious problem through the po-



ASSEMBLED DRIVING BOX.

sition of inaccessibility which this part now occupies. Drop pit work heretofore was not as a rule regarded as a particularly serious proposition in connection with roundhouse operations. In the majority of instances, with the exception of the main wheels, it became only necessary to take down the binder, and such of the side rods which might conflict, whereupon the subsequent procedure of lowering the wheel was simple, and in



BOX, SHOE, WEDGE AND KEY.

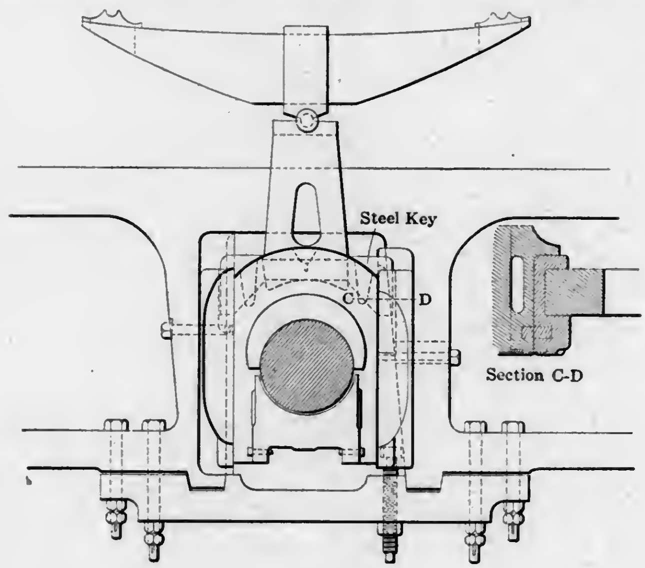
fact the entire job could be performed with comparatively little delay to the road time of the engine.

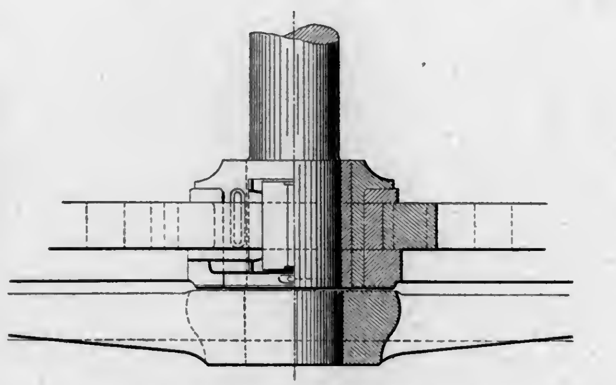
Recent complications, however, with the vastly augmented weight of the component parts have in many instances converted this undertaking into one of rather formidable proportions, and so prolonged the work that it is not unusual to see a locomotive held for two or even three days for the renewal of a driving box brass, or even a shoe and wedge.

With a full appreciation of these facts it is not surprising that the efforts of many clever mechanicians have for some time been directed toward securing some new form of driving box construction which would permit its removal without any recourse to the drop pit whatever, and without the general dismantling process which has become so prominently associated with it.

A recent device to this end which embodies many novel and decidedly interesting features has been recently patented and is now being tried out with satisfactory results on the Galveston, Harrisburg and San Antonio Ry. The construction of this, what may be called sectional driving box, can be readily understood from the accompanying illustrations. It permits the removal of the box, shoe and wedge, without the use of a drop pit or crane, and the labor of taking down and replacing connecting rods, pedestal binder, brake rigging, wheels, etc., is saved, the locomotive being out of service only a few hours.

It will be noted from the half-tone illustrations showing the separate parts of the box, and the entire arrangement in its as-





LOCOMOTIVE PEDESTAL WITH BOX APPLIED.

sembled form, that the former are held securely together by the use of a heavy steel key which unites the box, shoe and wedge on the side of the frame next to the driving wheel. To remove the driving box from the locomotive all required is to take the weight off the spring or equalizer, shift the saddle or equalizer to one side and lift out the key, whereupon, by reason of the box being unflanged at its outer end, it can be moved inward on the axle and taken out. Then the shoe and wedge may be removed without disturbing other parts.

The shoes and wedges, by reason of being built out on the outside, are adapted to take up the lateral thrust and part of the wear of the driving wheel hub. The driving box, although having no outer flange, appears to be adapted to resist the lat-

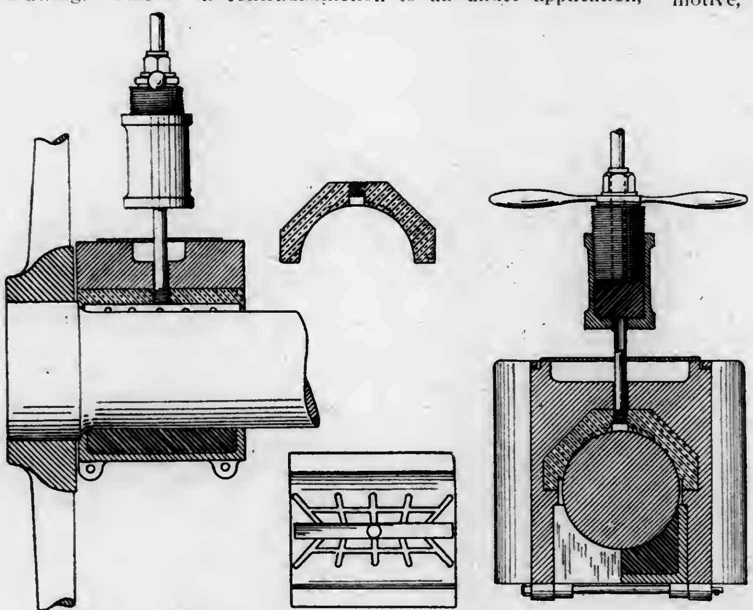
eral thrust of the driving wheel in the usual manner, this being secured by the presence of the key which prevents endwise movement of the box.

It is prominent in this construction that the wearing surface on the sides of the driving box has been increased nearly 50 per cent.; that the shoe and wedge have been materially strengthened, and that better lubrication appears possible. Wedges should not require adjustment as frequently as those generally used and frame failures will probably be reduced.

It is said that a driving box can be taken down in 30 minutes when of this design, and at a cost not to exceed 60 cents for labor, which, if the latter is accurate, represents a very considerable saving over the methods now in vogue. The device is comparatively inexpensive to apply to locomotives when undergoing general repairs. No new patterns are required, as the old shoe and wedge patterns can be built out. The machine work merely consists of planing off the outside flange of the box, and the application of but one additional member consisting of a substantial key held in place by the spring saddle or spring equalizer.

OVERHEAD GREASE FEED FOR JOURNAL BOXES

Lubrication of locomotive truck journals, working within the journal box, by means of hard grease applied from the top, is proposed by J. C. Martin, inventor of the device, in accordance with the arrangement shown in the accompanying drawing. This is in contradistinction to an under application,



MARTIN'S OVERHEAD TRUCK JOURNAL BOX LUBRICATOR.

and it is explained that owing to the weight of the locomotive it has not been found practicable to properly lubricate the journals by applying the lubricant to the under face, the weight being such as to prevent its proper distribution.

As a result it is required that frequent stops of the engine be made in order that proper attention may be given to prevent overheating. The object of the automatic overhead feed of the hard grease is to provide for adequate lubrication so long as the supply within the reservoir is maintained. It is intended through its use to dispense with these frequent stoppages, to insure against overheating, to increase the mileage for a given quantity of hard grease lubricant and in general to prolong the life of the journals.

The drawing is self-explanatory, but it might be mentioned that the plan purposes the use of solid journal bearings without babbit strips. In lieu thereof the bearing face of the brass is grooved as shown, the grooves being about 5/16 in. deep. The top of the journal box is drilled with a hole sufficiently large to clear the ½-in. pipe connection from the grease cup to the journal, this connection being screwed directly into the brass. It is recommended that the cellar be packed with dry waste, nearly full, and coated on top with hard grease, the object of the latter being to prevent taking away what has been applied from the top. The length of the ½-in. pipe is determined by whatever obstructions may intervene to the location of the lubricator. The latter, as will be clearly seen, is of the compression type and is readily operated by the cross handle.

HOISTING MAGNETS.—Two hoisting magnets handled by traveling cranes at the plant of the Inland Steel Company, near Chicago, are said to have unloaded 2,000 tons of pig iron from a steamer in 10½ working hours, while with manual labor this work requires 28 men working two days and two nights. Only the two crane operators were employed, except that at the last a few men were employed to shift the pigs within reach of the magnets. It is stated also, that at the Homestead plant of the Carnegie Steel Company two operators with electric traveling cranes equipped with hoisting magnets have done the work that formerly required 25 men.

OIL ENGINES FOR LOCOMOTIVES.—Following on the experiments of the North British Railway Company, whose locomotive engineer last year designed an electric locomotive, upon which there was a steam turbine driving a dynamo, which in turn supplied electrical energy to electric motors for driving the locomotive, a leading British Railway Company has, it is stated, given instructions for the preparation of designs for a 500 h.p. locomotive of a similar character, but using a Diesel engine for driving the dynamo instead of a steam turbine. It is reported that the results with the North British type of electric locomotive have not come up to expectations in the matter of economical working, owing to certain defects, which the use of the Diesel engine will, it is expected, remedy, and at the same time reduce the size and weight of the locomotive.

RECORD OF A PANAMA SHOVEL.—During September Steam Shovel No. 132, working in the burrow pit a Mt. Hope, excavated 42,600 cu. yds., of which 32,400 cu. yds. are classified as rock and the balance as earth. The shovel is served by three trains of about ten 10-yd. dump cars each. Delays were as follows: Mining, 3.00 hrs.; repairs, 0.45; moving shovel, 11.15; cutting out shovel, 3 times, 3.30; waiting for cars, 5.30; a total of 24 hours. Shovel was under steam 200 hours and worked 88 per cent. of that time. The average output per day was 1,704 cu. yds. place measurement.

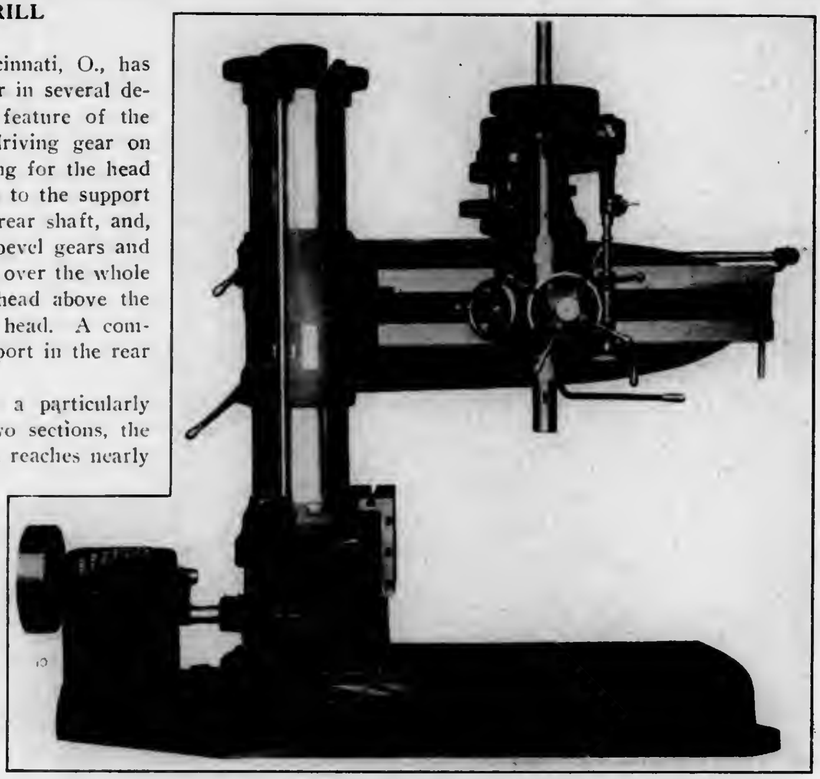
A MAMMOTH CRANE, THE LARGEST IN THE WORLD, has been erected at Govan, Scotland, for use in the construction of large steamships. It is of the cantilever type, and is 169 feet from rail level. The jib has a total length of 270 feet and extends 169½ feet outward from the center, and can be utilized within every point of a circle 336 feet in diameter. The crane on slow gear is capable of elevating 200 tons extended 75 feet along the jib and on quick gear 100 tons at 133 feet.

THE OXY-ACETYLENE PROCESS of cutting steel has been used in a noteworthy manner in connection with the salvage of the battleship *Maine*, the wreck of which is now being dewatered in Havana harbor. Much of the work involves the cutting of armor plate 9 inches thick, as well as the usual plates, beams and bars used in the structure of a ship.

A NEWLY DESIGNED RADIAL DRILL

The Dreses Machine Tool Company, of Cincinnati, O., has developed a line of plain radial drills which differ in several details from those formerly built. A prominent feature of the new machine is the mounting of the spindle driving gear on ball bearings, and the addition of an extra bearing for the head on the rear of the arm. This third bearing adds to the support of the head, prevents bending and strain of the rear shaft, and, still more important, minimizes the wear of the bevel gears and their bearings, and distributes the torsional strain over the whole arm. A single handle on the left side of the head above the face of the arm serves to clamp and release the head. A compound spiral gear arrangement and the third support in the rear enables it to move easily along the arm.

The general design of the machine suggests a particularly sturdy construction. The column is made in two sections, the outer one swinging on an inner fixed column that reaches nearly to the top. The diameters of both are greatly increased at the lower end. A third bearing has been introduced, which adds strength and rigidity. A place for a large roller bearing to rest and swing on is provided by the reinforced portions as well as means for clamping the column easily and firmly.

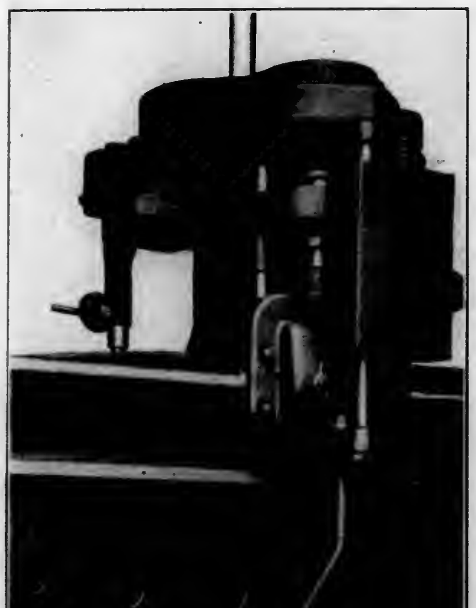


THE DRESES IMPROVED RADIAL DRILL.

The clamping handle is always within easy reach of the operator since it follows the arm, and no pressure is exerted on the rollers of the bearing when the arm is clamped in position. These rollers are tapered, of large diameter, and thoroughly protected from chips and dirt.

In the design of the spindle driving gear an important improvement has been made to reduce the friction to which this gear is subjected by the pull exerted upon it when the spindle feeds down. This has been accomplished by making the spindle driving gear rest and revolve on a ball bearing.

The mechanism for the feed, which is of the all-geared type, is enclosed in a small case. Eight changes in all are available; four of these ranging from 0.007 to 0.022 in. per revolution of the spindle are secured by the little handle on the feed shaft at the right of the head and are increased from 0.026 to 0.80 in. by the small crank above, both being within easy reach of the operator. The use of a ratchet clutch enables the hand feed to work ahead of the power feed. A swinging dog attached to an extension on the spindle sleeve is brought into contact with an adjustable dog on the feed bar, and there is a graduated scale by which the depth of a hole can be gauged from zero. Several of these dogs can be put on the feed bar and the swinging dog brought into contact with them successively for different depths of holes. A safety release for the end of the feed is provided. The quick advance and return device has four levers, any one of which engages and disengages the feed instantly, and also serves as a pilot wheel for hand operation of the spindle.



ADDITIONAL BEARING FOR HEAD.

The starting, stopping and tapping mechanism, which is of the friction type, is embodied in the head and operated by the horizontal lever shown below the arm in the illustrations. The large diameter friction bands are double expanding and are made of phosphor bronze to avoid cutting. The bevel gears containing the frictions run in an oil bath. The speed changing lever on the head enables the tap to be backed out at 2½ times the cutting speed. Three speed changes, rendering 21 different spindle speeds available, are provided for the head, the arrangement being patterned after automobile transmission gearing.

Any desired speed can be secured without stopping the machine. The speed variation is of the tumbler gear type and has seven changes. The teeth are of the 20 degree involute pointed form to insure strength and easy engagement. To overcome momentum when starting, the speed variator runs at the slowest speed at all times and is provided with the builders' self-releasing overtake clutch. In the variator one gear runs loose on the variable-speed shaft and is clutched by four pawls located in fixed gears mounted on this shaft. These pawls are kept in contact with the inner surface of the gear by spiral springs and will release the two gears when the fixed ones run faster than the loosely mounted one.

Three sizes of tool with arms 5, 6 and 7 ft. long are built and range in weight from 10,000 to 16,000 lbs. In a test of the middle size an 8-in. pipe tap was fed in a 2½-in. plate, and a hole was drilled in cast iron by a 4-in. high speed drill at a cutting speed of 100 ft. per minute and a feed of 0.027 in. per revolution of the spindle.

AIR PRESS FOR ROD BUSHINGS

CHICAGO & NORTH WESTERN RY.

A very useful contrivance for the application and removal of rod bushings is shown in the accompanying drawing. It was evolved and is in use at the Winona, Minn., shop of the above road and is said to be a great time-saver over the method formerly in vogue of doing this work on a wheel press, an improvement in fact amounting to the handling of ten bushings to one.

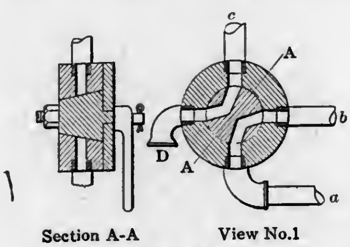


FIG. 2

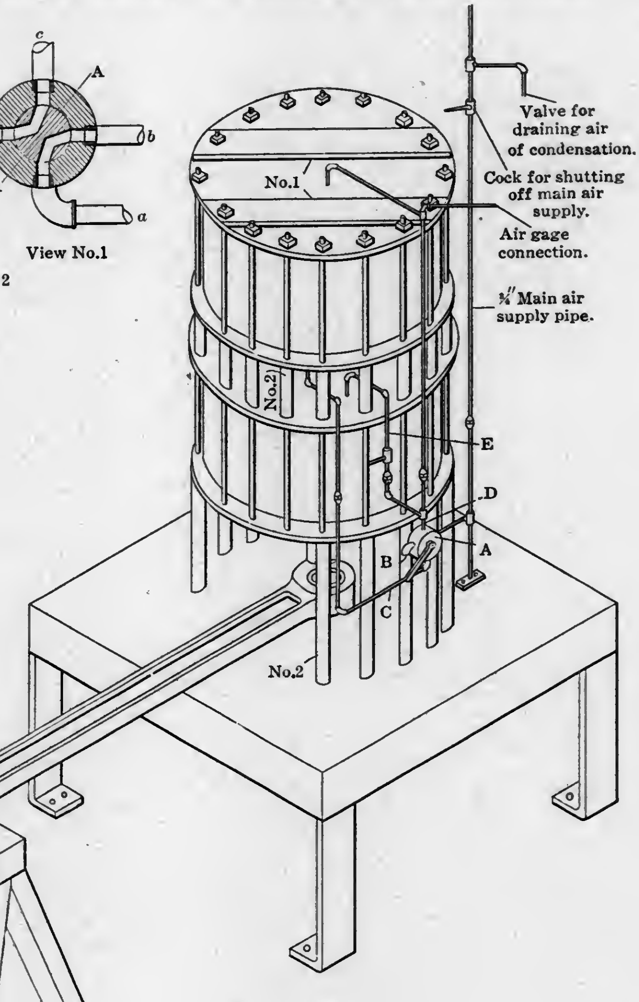


FIG. 1

A CHEAP AND EFFECTIVE ROD PRESS.

It will be observed that the press consists of two cylinders. These are 21-in. diameter by 12-in. stroke, and were made from a locomotive cylinder bushing. The heads are of ½-in. boiler steel, reinforced by two 1-in. x 3½-in. pieces of flat iron. The pistons are of ½-in. boiler steel, with a collar riveted in the center which acts as a reinforcement for the piston rod, and 1½-in. angles riveted radially for additional strength. The entire contrivance is held together with sixteen one-inch bolts, as shown in Fig. 1, part of them running through the work table, and the others only to the bottom head. Pieces of pipe (No. 2) around these bolts act as separators for the cylinders and between the lower cylinder and the table.

The apparatus is controlled by the three-way valve shown at (A), Fig. 1, and in section in Fig. 2. This is made of round stick brass with a taper plug similar to a cutout cock. Holes are drilled in the body and the plug as shown. (a) connects with the top cylinder and under the piston for raising both pistons; (b) with the main supply pipe, and (c) with both cylinders on top of their pistons for pressing in the bushings. When the valve is in the position shown in Fig. 2, the main supply is connected with pipe (c), Fig. 1, and the pistons are raised, while pipe (D) is connected with the exhaust (d), Fig. 2. By placing the handle in mid position the valve is closed; in the extreme position the main supply is connected with pipe (D), Fig. 1, and pipe (c) is in connection with the exhaust.

As an index of the pressure employed a common air gauge, registering to 100 lbs., was made use of by pasting a circle of paper on the dial with the approximate tons marked opposite each ten-pound division, this ratio being easily computed as follows: the area of the two pistons = 692.72 sq. in., divided by 2,000 = .346 tons for one pound pressure, and multiplied by 10. 20, etc., gives the equivalent entirely around the dial.

This press is placed near the end of the rod department in the Winona shop and is served by a one-rail traveling air hoist.

PENNSYLVANIA'S GREAT COAL PRODUCTION.—In the combined production of anthracite and bituminous coal Pennsylvania outranks any of the coal-producing countries of the world except Great Britain and Germany, and in 1910, reports the United States Geological Survey, it came within 10,000,000 short tons, or less than 5 per cent., of the output of Germany. Pennsylvania's production in 1910 was more than four times that of Austria-Hungary in 1909, more than five times that of France in 1910, and nearly 20 per cent. of the total world production. The industry, particularly in the bituminous districts, has kept pace with the manufacturing industries and has increased in considerably larger ratio than the population of the State and of the United States as a whole. From 1814 to the close of 1910 the total production of anthracite had amounted to 2,180,323,469 short tons.

CEMENT PRODUCTION IN 1910.—Ernest F. Burchard, of the United States Geological Survey, reports that in 1910 the production of Portland cement in this country reached the enormous total of 76,549,951 barrels, with a value of $68,205,800. This is equivalent to 12,986,152 gross tons, valued at $5.25 a ton. It is an increase over the output for 1909 of 11,558,520 barrels, or nearly 18 per cent., and an increase in value of $15,347,446, or more than 29 per cent. This increase alone is greater than the total output of Portland cement in 1900. In addition to Portland cement there was also produced last year 1,139,239 barrels of natural cement and 95,951 barrels of puzzolan cement, a total of 77,785,141 barrels.

The price of Portland cement in 1910 was as low as 73 cents a barrel in some places, the average for the United States being 89.1 cents a barrel. In 1890 the average price was over $2 a barrel and as late as 1903 it was $1.24 a barrel. These figures are of considerable interest as indicative of the great demand for this product.

ELECTRIC POWER FOR RAILWAY SHOP*

There are three systems of generating current for operating shop machinery; alternating current, direct current, and a combination of both. The first modern repair shops used direct current exclusively. This was due both to lack of knowledge concerning the characteristics and uncertainty regarding the feasibility of using alternating current; also the high cost of motors and generating apparatus which then prevailed. About seven or eight years ago shops were installed using a combined alternating current and direct current system. In some cases both direct current and alternating current prime generating units were used, and direct current was obtained through the medium of a motor generator set or a rotary converter. The advantages of the latter arrangement are numerous, but the flexibility of operation and the high efficiency of large units would form a determining factor in deciding on this method in preference to the former.

During the past five years several installations have been made where alternating current is used exclusively, probably the most prominent being that of the New York, New Haven & Hartford shops at Readsville, Mass. The committee is dubious, even at this time, as to whether or not the best plan is to use alternating current to the exclusion of direct current, as no doubt exists but what increased output can be obtained from certain classes of machine tools by the use of variable speed direct current motors. in view of the present high labor costs, this is certainly an important consideration. The recent development of multi-speed alternating current motors, and the increased use of variable speed alternating current motors in conjunction with mechanical gear changes, however, may in a short time alter present engineering practice.

Practically all of the machine tool builders have so arranged their machines that the constant speed motor drive may be used through the medium of mechanical gear changes, and in small shop installations where the power plant capacity does not exceed 500 kw., it would seem inadvisable to complicate power distribution by installing both alternating and direct current, inasmuch as the relative saving in labor would be less than in a large shop where, as in a great many cases, manufacturing is done for smaller shops on the system.

In the first place, we must consider the original cost, beginning at the power plant and ending at the motors which drive the machinery. The cost of certain parts of the power plant will remain practically constant, regardless of whether or not direct or alternating current is used, provided, of course, that the same method of operating generating units is decided on. If alternating current turbines are compared with direct current generators with cross-compound condensing engines, the cost of the building and foundations would be considerably greater for the latter installation; the boilers, condensers and other accessories would remain practically the same. We should assume, however, that the comparison would be between alternating current turbo-generators, and direct current turbo-generators; in which case the cost of the building and all equipment, exclusive of the generating units, would be essentially the same. Where alternating current is decided on the installation of turbines is practically the only thing considered, as recent developments in the design of non-condensing units makes them eminently satisfactory where water cannot be secured for condensing purposes. In the case of direct current many engineers prefer engine type units to turbo-generator units.

We give below the approximate first costs of generating units in a power plant installation to provide power and light for a large locomotive and car repair shop, with fifty pits in erecting shop, and sufficient car repair facilities to take care of the division on which the shop is located. Undoubtedly, for a shop of this character and size, most engineers would decide upon three prime generating units of approximately 750 kw. capacity each; and, if a combination system is considered, two motor generator sets of approximately 300 kw. capacity each, to provide direct current for the variable speed machine tools and, possibly, for the cranes. The first cost for generating units will be as follows:

Alternating current (turbines)	$41,500
Alternating current (engine type generating units)	74,500
Direct current (turbines)	65,000
Direct current (engine type generating units)	72,000
Alternating and direct current (turbines)	51,500
Alternating and direct current (engine type generating units)	84,500

Special attention is called to the fact that the above estimate on a combined system, contemplates the use of a synchronous motor in connection with the motor generator set as a power factor corrective device. It is the usual method for electrical manufacturers to rate alternating current generating units on the basis of 80 per cent. power factor. By actual practice, however, it has been ascertained that the power factor usually prevailing in both manufacturing establishments and railway shops, will vary from 55 per cent. to 75 per cent., rarely being as high as 80 per cent. On this account it is generally advisable to install a synchronous motor in the power plant, which can either be efficiently used for driving direct current generators or as a synchronous condenser, floating on the line to bring the power factor up to the desired point.

It is clearly evident that a straight alternating current installation is far cheaper in first cost, from the power plant standpoint, than either of the alternatives. Next, the distributing system must be considered. We are practically limited on account of commutation to 250 volts as a potential for transmitting direct current, but in the case of alternating current 440 volts or 550 volts are generally used. Taking into consideration transmission line losses alone, we can transmit nearly four times the power at 440 volts alternating current as at 250 volts direct current, with the same percentage of loss. In shop practice, however, the limited distance at which power is transmitted generally makes the current carrying capacity of the wire a determining feature, rather than the losses through resistance. On this account it will probably be found that the transmission lines for alternating current will require about 60 per cent as much of copper as those used for direct current. The percentage of loss, however, will, of course, be considerably less, on account of the higher voltage at which the current is transmitted.

It has been customary where direct current is used to operate both arc and incandescent lamps from a 250-volt circuit. With an installation of this character, the life and efficiency of incandescent lamps are greatly reduced, and the arc lamps do not operate as successfully as on a 125-volt circuit. The development of the tungsten lamp for shop lighting has practically made imperative the use of 125-volt transmission, which in the case of direct current would require special generators for this service, on the assumption that 250 volts has been standardized for power service. It is very simple in the case of alternating current to obtain the low tension lighting voltage, as the transmission can be made at the full voltage of the generating unit, and transformed to the desired potential near the point at which it is used.

Some consideration must be given to the relative cost of alternating current and direct current motors for operating machinery and cranes. We would estimate that the cost of alternating current motors for individual and group drive would be less than direct current motors, but the cost of alternating current motors for cranes will be somewhat in excess of direct current motors, as the fundamental principles of alternating current motor construction make is necessary to use on cranes much larger alternating current motors than direct current motors. The ease of speed control, however, is approximately the same, and it is doubtful if an operator could tell from the operation of the crane whether direct current or alternating current motors were applied.

As a general proposition, it is only fair to assume that the difference in first cost of electrical equipment for a large railway repair shop, based on the use of alternating or direct current, would be mainly represented by the difference in cost of

* Abstract of a committee report at the Chicago meeting of the Association of Railway Electrical Engineers, November, 1911.

the power plant equipment. The saving in the transmission system, by using alternating current, and the lower cost of alternating current motors for driving machine tools, would be practically counterbalanced by the increased cost of alternating current motor driven cranes and variable speed machines, where it is necessary to provide them with mechanical speed changes.

We should bear in mind the possible necessity in the future of transmitting current for a long distance for the purpose of operating pumps, or furnishing light to depots or other property removed from the power plant. Also the possible likelihood of purchasing alternating current from a hydroelectric company based on rates lower than the same current could be generated by the railway.

The general conclusion is that alternating current should be used exclusively in small division railway repair shops, where the capacity of generating units in the power plant does not exceed 500 kw., and that the combination of alternating current and direct current should be used in larger installations. The direct current units should be installed for the purpose of operating variable speed machine tools only. The use of alternating current for operating cranes, transfer tables, turntables and hoists is recommended as being wholly satisfactory, and no reason exists for converting alternating current to direct current for any of these purposes.

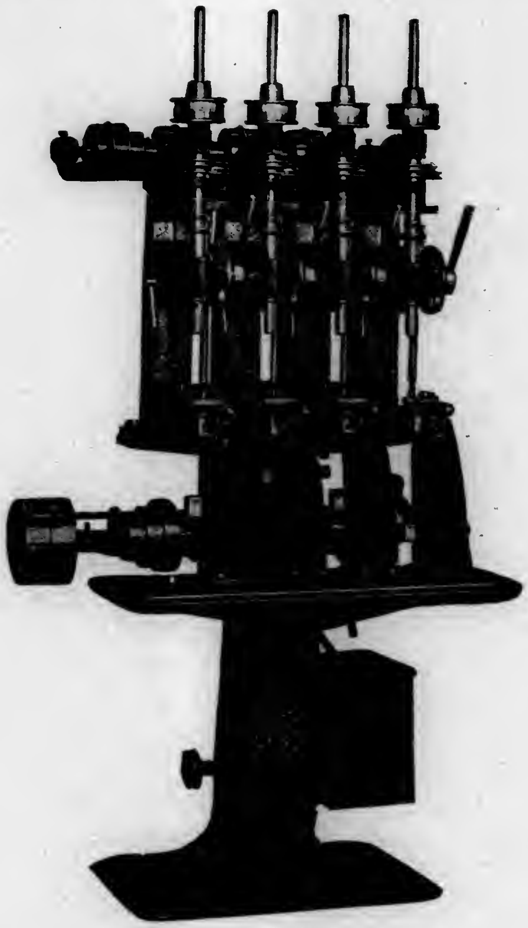
The modern railway shop requires compressor capacity of 1,000 to 10,000 cu. ft. of free air. In order to obtain this volume, it is necessary to use steam representing from 150 to 1,500 boiler h.p., which probably equals the amount of power necessary to operate all shop equipment driven by other methods. We desire to unequivocally endorse the substitution of electric power for compressed air wherever possible, and the development of electric drive for hoists, riveters, chipping hammers, drills, etc., makes it wholly practical to eliminate the majority of pneumatic appliances. It is also desirable to distribute a number of small compressors through the various buildings, these compressors to be electrically driven and arranged to automatically start and stop through pressure governors. While this method may not be wholly feasible under present operating conditions, it would not only be feasible but strongly advisable if the compressed air consumption is greatly reduced by the substitution of electrical equipment as above indicated.

FOUR SPINDLE STAYBOLT DRILL

In view of the recent recommendation of the Interstate Commerce Commission in regard to the use of telltale holes in boiler staybolts, the machine illustrated above is of particular interest at this time. Athough not a new tool in the strict sense of the word, as there are over a hundred in operation in various railroad shops, this staybolt drill herein illustrated, a product of the Foote-Burt Company, Cleveland, O., has been re-designed to take care of increased strain which is inseparable from the use of high speed steel.

The machine has a capacity of four 5/16 in. drills. and will take in staybolts from ¾ in. to 1¼ in. in diameter, and from 3 in. to 15 in. long. Each spindle is provided with three independent speeds and has two changes of power feed. Power feed is equipped with automatic knock-off, which can be set for any depth within the capacity of the machine. Both feed and speed can be readily changed on any spindle without changing the other spindles. Specially designed chucks with simple, quick acting gripping mechanism center the staybolts beneath each spindle and hold them rigidly in position. A hardened bushing is provided for the drill to run in, insuring its starting central with the piece held in the chuck. An oil pump is provided with suitable return tank so that liberal quantities of lubricant can be used.

On account of the extremely simple design of this machine and its ease of operation, a boy can readily keep all four spindles running to their maximum capacity, reducing piece costs to the minimum. The staybolt chucks are readily removable, leaving the machine available for a variety of sensitive drilling when necessary. The many praiseworthy features of this new



machine and its capacity would indicate that it is an indispensable adjunct to a boiler shop, especially one engaged on locomotive work.

The Results of Pennsylvania Railroad Forestry.—A fine example of what may be done in the way of reforestation is shown by the Pennsylvania Railroad. This road started some years ago to plant trees on its own property in all appropriate places, setting large numbers of them in previously unused places alongside the tracks. It has begun to reap the harvest. In the last three years the Pennsylvania has used 2,600,000 board feet of lumber and 15,000 trees grown by this system on its own land. The company is constantly increasing its wooded area, and hopes ultimately to supply all its own needs in the way of track ties and timber for other purposes.

A Conference on Car Wheels was held in New York on November 10, at the Waldorf-Astoria Hotel, and the following were among those representing the Master Car Builders' Association: W. Garstang, superintendent of motor power, Big Four Railroad, Indianapolis, Ind.; C. A. Brandt, mechanical engineer, Big Four Railroad, Indianapolis; R. L. Ettenger, consulting mechanical engineer, Southern Railroad, Washington, D. C.; J. M. Henry, master mechanic, Pennsylvania Railroad.

It is Stated that the Following Preparation will keep machinery clean for months under ordinary circumstances, as, for instance, in a show room: One ounce of camphor, dissolve it in 1 lb. of melted lard, and add enough plumbago powder to make the mixture the color of iron. Clean the machinery, and smear it with the mixture. After 24 hours rub to a finish.

PROPOSED SPECIFICATIONS FOR POSTAL CARS

Specifications covering the construction of all steel and steel underframe postal cars are desired by the post office department, and it has called upon the railways for their co-operation and assistance. After several conferences, the sub-committee of mechanical officers of the Special Committee on Relations of Railway Operation to Legislation, the committee of the post office department and the chief engineers of the leading car building companies have submitted to the railways a proposed specification which will be brought up for discussion at a meeting on December 4 at Washington, D. C.

The proposed specification is as follows:

GENERAL.

Type.—Postal cars may be built according to any of the following types of construction: (a) Heavy center sill construction, the center sills acting as the main carrying member. (b) Side carrying construction, the sides of the car acting as the main carrying members having their support at the bolsters. (c) Underframe construction in which the load is carried by all the longitudinal members of the lower frame. The super-structure framing may be of steel or of wood re-enforced as per R. M. S. Specification Plan No. 1. (d) Combination construction in which the side frames carry a part of the load, transferring same to the center sills at points remote from the center plate for the purpose of utilizing uniform center sill area. Steel castings may be used as parts of the underframe in any of the above types.

Materials.—All rolled steel plates and shapes used in the car framing shall be made by the open-hearth process. The physical and chemical properties of all material used in the car framing shall be in accordance with the latest standard specifications of the American Society for Testing materials, as follows: The standard specification for structural steel for bridges, for steel plates, shapes and bars; the standard specification for wrought iron, for iron bars and plates; the standard specifications for steel, malleable iron and gray iron castings.

Workmanship.—All workmanship throughout the car shall be first-class. The jointing of the car framing shall be made so that the structure as a whole shall be built to dimensions specified, and all joints exposed to the weather shall be made tight against leakage.

Live Loads.—The car body shall be designed to carry the specified live load in addition to its own dead weight under service conditions. Where no live load is specified the maximum capacity of the car, as determined by wheel loads, shall be used as a basis for calculations.

Buffing.—The maximum end shock due to buffing shall be assumed as a static load of 400,000 lbs applied horizontally at the resultant line of the forces acting at the center line of the buffing mechanism, and at the center line of draft gear respectively, and shall be assumed to be resisted by all continuous longitudinal underframe members below the floor level, provided such members are sufficiently tied together to act in unison

Details.—All connections, except those specified in the second paragraph under end construction shall be designed for the maximum strain to which the member connected shall be subject, and secondary stresses in any members caused by eccentric loads shall be properly combined with the direct stresses in such members. The maximum fiber stress in any member subject to both direct and secondary stresses may be taken at 20 per cent. greater than those given in the paragraph on stresses, but the direct stresses considered alone must not exceed the allowable stresses given in said paragraph.

The minimum distance between centers of rivet holes shall be three diameters of the rivet, and the minimum distance between the center of the rivet hole and a sheared edge shall be not less than one and one-half times the diameter of the rivet. Below the floor line, framing connections of floor beams, posts, etc., may be of rolled steel, pressed plate, or cast steel, and above the floor line such connections may also be of malleable iron. Connections for I-beams, channels or tees may also be made by coping the flanges and bending the web to form a knee, and for angles by coping one leg and bending the other. The use of fillers in the underframe and superstructure shall be avoided wherever possible. All holes for rivets or bolts in the underframe, superstructure and outside finish shall be drilled or punched and reamed to size and fairness. No drifting of holes will be allowed. In deducting rivet or bolt holes to obtain the net area of any section, they shall be taken at 1/16 in. larger than the diameter of the rivet or bolt. The effective area of a rivet shall be taken as its area before driving. All rivets when driven must completely fill the holes and have full concentric heads or be countersunk when required.

Center Sills.—The center sills may be built up or composed of rolled or pressed shapes, either with or without cover plates, and cast steel draft sills or end construction may be used in connection with any of the above types, with suitable riveted connections at splices. Built-up center sills may be either of uniform depth or of the fish-belly shape, and may be composed of rolled shapes, web plates, flange angles and cover plates. If preferred, the web plates may be flanged and angles omitted. When flange angles are used they shall be connected to the webs with a sufficient number of rivets to transfer the total shear at any point in a distance equal to the depth of the sill at that point. When cover plates are used they must extend at least two rows of rivets at each end beyond their theoretical length.

Bolsters and Cross Bearers.—The body bolsters and cross bearers may be of either cast steel or built-up construction, with ample connections at the center and side sills to transmit the calculated vertical shear.

Floor Beams.—Transverse floor beams may be of rolled or pressed shapes, with suitable connections at center and side sills.

Floor Supports.—Longitudinal floor supports shall be supported at each transverse floor member.

End Sills.—The end sills may be either of rolled or pressed shapes, built-up construction or cast steel, with ample connections at center and side sills. They must be designed for the maximum vertical loads to which they may be subject and also for the assumed horizontal loads transferred from the vertical end members as specified in the third paragraph under "end construction."

SIDE FRAME.

General.—In calculating the stresses in the side frame its effective depth when designed as a truss or girder may be taken either as the distance between centers of gravity of the side plate and side sill or as the distance between centers of gravity of belt rail and side sill. At the side door openings the bending moment caused by the vertical shear at the door post shall be considered as being resisted by the section above and below the door openings, and the sum of the direct stresses and those due to bending at such section shall not exceed the stresses specified. A sufficient proportion of any reinforcing members added to these sections shall be extended far enough beyond the door posts at each side so that their reaction can be taken care of by the side frame without exceeding the limit specified for stresses.

Posts.—The sum of the section moduli taken at any horizontal section between the floor and the top line of windows, of all posts and braces on each side of car, located between end posts, shall be not less than .30 multiplied by the distance in feet between the centers of end panels, a panel length being considered as the distance between lines of rivets in adjacent vertical posts.

Sheathing.—Outside sheathing plates shall be not less than ⅛ in. in thickness.

ROOF.

General.—The roof may be of either the clear-story or turtle-back type, depending on the standard contour of the railway for whose service the cars are built. In the clear-story type the deck plates shall be in the form of a continuous plate girder, extending from upper-deck eaves to deck sill, and either built up of pressed or rolled shapes or pressed in one piece from steel plates. The carlines may be of either rolled or pressed steel shapes, extending in one length across the car from side plate

to side plate, or may extend only across the upper deck. In the latter case the lower deck carlines may be formed by cantilever extensions of the side posts or by independent members of pressed or rolled shapes. In the turtle-back type, the carlines may be of either pressed or rolled shapes, extending in one length across the car between side plate and side plate, or may consist of cantilever extensions of the posts.

Carlines.—The projected area of the portion of roof in square feet supported by carlines, divided by the sum of the section moduli of the carlines must not be more than 100.

Roof Sheets.—Roof sheets, if of steel or iron, shall be of a minimum thickness of 0.05 in., and either riveted or welded at their edges.

END CONSTRUCTION.

Vertical End Members.—The sum of the section moduli of all vertical end members shall be not less than 35, and the section moduli of the main members, either forming or adjacent to the door posts, shall be not less than 75 per cent. of this amount.

The horizontal reactions of all vertical end members at top and bottom shall be calculated from an assumed external horizontal force applied 18 in. above the floor line, to all vertical members in the proportions given above, such force being of sufficient amount to cause bending of all vertical members acting together, and top and bottom connections of vertical members shall be designed for these reactions.

Except where vertical end members shall bear directly against or be attached directly to longitudinal members at either top or bottom, the assumed reactions shall be considered as loads applied to whatever construction is used at end sill or end plate, and both these last named members shall have section moduli, respectively, sufficient to prevent their failure horizontally before that of the vertical end members.

End Plate.—The end plate may be a rolled or pressed section, or of built-up construction, and shall extend across the end of the car from side plate to side plate, with ample connections at the ends, or shall be of other satisfactory construction to withstand the assumed loads given above.

Stresses.—All parts of the car framing shall be so proportioned that the sum of the maximum unit stresses to which any member is subject shall not exceed the following amounts in pounds per square inch, except as modified in the first paragraph under "details," the second and third paragraphs under "end construction." These stresses, unless otherwise stated below, are for steel having an ultimate tensile strength of from 55,000 to 65,000 lbs. per square inch. Where other materials are used, they shall bear the same proportion to the ultimate strength of the material used.

The stress in built-up bolsters shall not exceed 12,500 lbs. per square inch.

The stress in cast steel for bolsters and other details shall not exceed 8,000 lbs. per square inch.

The stress in sills and framing shall not exceed 16,000 lbs. per square inch.

For members in compression the above stresses shall be reduced in accordance with usual engineering practice.

RIVETS (RIVET STEEL).

Shear, other than buffing	10,000	lbs. per	sq. in.
Bearing, other than buffing	20,000	"	"
Shear, buffing	12,000	"	"
Bearing, buffing	24,000	"	"

Floor.—Sub-floor of postal cars to be of iron or steel plate, upper or wearing floor of composition or of matched wooden flooring, maple or yellow pine preferred, with proper insulation. Composition flooring may be secured by corrugated, keystone or equivalent style of plate or by wire fastening which is anchored to the sub-floor.

Interior Finish.—Inside, side and end linings and head lining of postal cars to be of flat or corrugated steel plate, composition board or wood, preference in the order named, properly secured to the car framing.

Insulation.—Suitable fabric or material shall be used as an insulation against cold or heat in the side and end walls and roof of steel postal cars, securely fastened as the nature of the material may require for efficiency and durability.

Doors and Windows.—Postal cars to be equipped with such side doors, end doors and side windows as are shown on the standard plans of the R. M. S. department. Doors and windows may be made of wool or metal and when glazed the glass shall be double strength. Trimmings and locks to be the railway company's standards. Doors and windows, including swinging deck sash, to have suitable weather stripping.

Lighting.—Lighting of postal cars primarily to be with electricity or gas with candles provided for auxiliary light. Distribution of light shall be in accordance with the requirements of the working space and doorways. Electric light installations on postal cards shal include distribution, preferably by condulet system with separate circuits, cut-outs, and switchboard regulation; lamps to have shades of railway company's standard. The generator, distribution, battery boxes and their equipment, train connectors, charging plugs, other accessories, and all wiring to be as per the railway company's standard practice. Gas lighting installations on postal cars to be in accordance with the railway company's standard practice.

Heating.—Heating of postal cars primarily to be with steam, applied either as a vapor system, with separate regulation for each coil, hot water steam heated, or direct pressure steam, with preference in the order named. Pipes are to have suitable protection guards of wire or perforated steel. For postal cars running into territory requiring them, an auxiliary coal burning stove shall be furnished, complete with coal box and firing tools, smoke jack and protection guards. The stove and coal box to be securely fastened. The stove may be used to heat direct or to heat the coils of an auxiliary hot water system. The train pipe steam line to be applied and equipped with end valves, steam hose and couplings, as per M. C. B. requirements and the railway company's standards.

Ventilation.—Ventilation of postal cars of clear-story design to be accomplished by means of swinging deck sash protected by screens. Trimmings of swinging deck sash to be railway company's standards. Postal cars not having clear-story roofs are to have a sufficient equipment of self-acting ventilators in the roof.

Vestibules.—Postal cars are to be equipped with railway company's standard short vestibule.

Couplers and Draft Gears.—The details of the coupler and draft gear to be in accordance with M. C. B. and U. S. safety appliance requirements, and the practice of the railway for which the cars are built.

Buffing Mechanism.—The details of the buffing mechanism to be in accordance with the practice of the railway for which the cars are built.

Brake and Signal Equipment.—Postal cars to be equipped with automatic air brakes and signal equipment of the latest design railway company's standard. Hand brakes in accordance with U. S. safety appliance standards. Brakes to be applied to all wheels, and to be preferably arranged inside on four-wheeled trucks. The braking power should not be less than 80 per cent. of the light weight of the car, based on 60 lbs. air pressure in the air brake cylinder. Suitable cord or attachments shall be furnished for convenient operation of the conductor's valve and train signal system.

Steps, Handholds, Signal Brackets.—The details of the steps, handholds and signal brackets to be in accordance with U. S. safety appliances and M. C. B. requirements and the practice of the railway for which the cars are built.

Stanchions and Screens.—Permanent stanchions in storage ends and at ends of pouch racks, screen frames, and screens to be located as per standard R. M. S. plans.

Safety Bars.—Safety bars to be applied in an equivalent manner to that called for in R. M. S. specifications, plan No. 1.

Interior Equipment.—The following list of equipment shall be arranged as shown on standard R. M. S. drawings, the details as per railway company's standards: letter cases, pouch racks, paper boxes, distributing table, hinged table, shelf and letter drop, general order case and tag case, drawers, pouch catcher, cinder guards and brackets, hopper, wash stand, water cooler, water tank, mirror, wardrobe, fire buckets, fire extinguishers, and wrecking tools.

TRUCK.

General.—Trucks may have either the built-up metal or cast steel frames, and may be either of the four-wheel or six-wheel type, within the limit of wheel loads given below. For cars equipped with one cast iron brake shoe per wheel the effective maximum emergency brake shoe pressure must not exceed 18,000 lbs. per shoe. When two brake shoes per wheel, or one shoe per wheel having a higher coefficient of friction than cast iron are used, the wheel loads may be increased to the allowable carrying capacity of the M. C. B. standard rules.

Wheel Loads.—Maximum weight of loaded cars must not exceed 15,000 lbs. per wheel for M. C. B. standard axle having 5 in. x 9 in. journals, or 18,000 lbs. per wheel for M. C. B. standard axle having 5½ in. x 10 in. journals.

Details.—Wheels shall be either all-steel or steel-tired. All other truck details, including body and truck center plates and side bearings, shall be in accordance with M. C. B. requirements and the practice of the railway for whose service the cars are built.

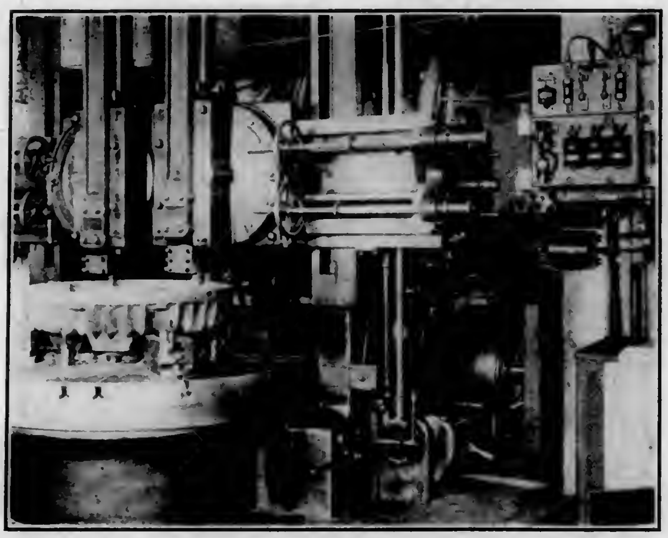
Painting.—The painting of car body and trucks shall be in accordance with the railway company's specifications for steel cars.

Lettering and Numbers.—The lettering and numbers of postal cars to conform to R. M. S. requirements and the railway company's standards.

AUTOMATIC CONTROLLERS FOR MOTOR DRIVEN MACHINERY

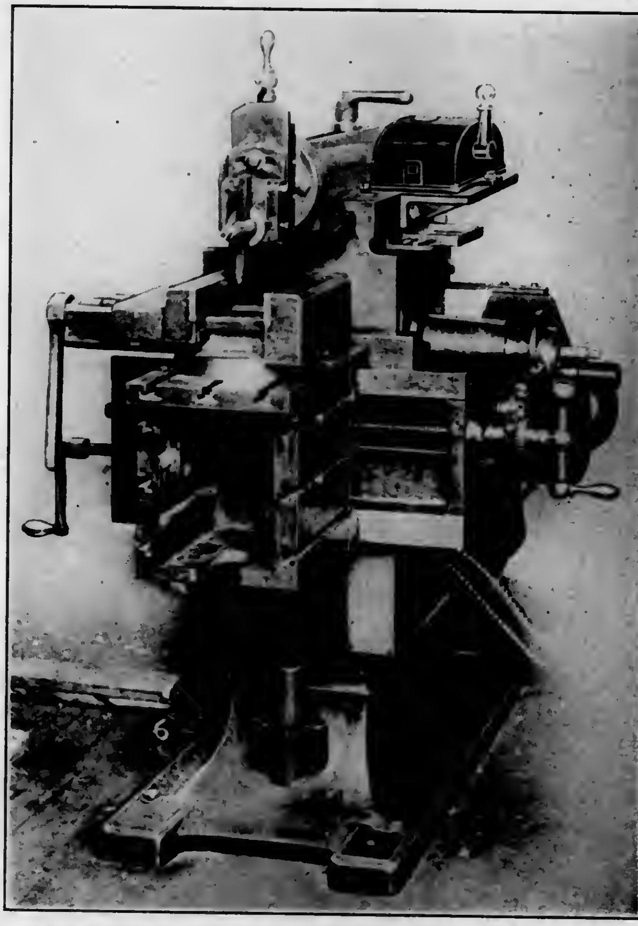
The Electric Controller & Manufacturing Company, of Cleveland, O., has recently placed on the market a line of automatic controllers designed for the specific purpose of giving the utmost convenience in the control of motor driven machinery. It has been estimated that the output of many machines can be increased 20 per cent. by the central grouping and convenient arrangement of all the operating levers. Handiness of control is recognized as being very important in securing the utmost production from a machine, and the automatic controllers described in this article were designed to provide this handiness of control for starting, stopping, or reversing the motor and machine.

The controller consists of a small operator switch and an accelerating unit. The controllers are built in three types to secure: (1st) non-reversing and dynamic braking; (2nd) reversing without dynamic braking; (3rd) reversing and dynamic braking. In each type a variety of four different forms of accelerating units are offered. These accelerating units vary in their design from a simple train of accelerating switches up to a unit having a fused service switch, a train of accelerating switches, and complete circuit-breaker features.



AUTOMATIC CONTROLLER ON BORING MILL.

The accelerating unit automatically accelerates or decelerates



MOTOR DRIVEN SHAPER EQUIPPED WITH AUTOMATIC CONTROLLER.

the motor through the action of series wound accelerating switches which possess the remarkable characteristic of acting, not only as switches, but as current limit relays as well. When the current in the winding of one of these switches exceeds a predetermined value the switch locks open and cannot close until the current is reduced to the proper value.

When the operator's switch is thrown to the running position, current flows through the motor, all of the starting resistance, and the coil of the first series wound accelerating switch. As the motor accelerates the current drops, and when it reaches the correct value the first accelerating switch closes, cutting out a portion of the starting resistance. The succeeding accelerating switches operate similarly, ultimately cutting out all of the starting resistance and putting the motor across the line. By throwing the operator's switch to its original position, the motor is disconnected from the line and consequently stops. Different positions of the handle of the different types of operator's switch provide for drifting, reversing, or rapid stopping by dynamic braking. Dynamic braking is secured by a change of connections, accomplished by the operator's switch, which first inserts all the starting resistance in series with the armature. The motor is then quickly and evenly brought to rest by automatic dynamic braking, the accelerating switches, in this case, acting as decelerating switches by cutting out, step by step, the resistance as the current, generated by the motor, decreases due to the slowing down of the motor.

The manufacturers claim the following important advantages for this automatic controller: 1st—It limits the acceleration and deceleration current at all times to a safe value. 2nd—It accelerates and decelerates the motor in the minimum, safe amount of time, and automatically varies the time of acceleration and deceleration, depending upon the load which the motor has to

start and stop. 3rd—It provides the best conditions for good commutation. 4th—By limiting the current, both in starting and stopping, it limits all mechanical strains on the motor and driven machinery. 5th—It obviates the necessity of mechanical clutches on many motor-driven machine tools. 6th—It adds very materially to the safety of an installation, since in case of accident the motor may be quickly stopped. 7th—It inherently provides no-voltage protection, for if the voltage fails the switches drop open, and upon the return of voltage they automatically close in their regular method and sequence, again accelerating the motor to full speed.

AN UNIQUE STEEL STORAGE BIN

One of the later products of the Berger Manufacturing Co., of Canton, O., is a very interesting steel storage bin which embodies the decided novelty of having shelving adjustable to the size of the articles to be stored. This is done by rearranging the partitions, which are easily inserted and bolted in place. Wherever small appliances and parts are carried in bulk, such as valves, nuts, bolts, screws, pipe elbows, unions, etc., this is a

great improvement over the design of the uniform wooden bins such as are ordinarily encountered in railroad storehouses, and which unquestionably waste a vast amount of space, as all bins are of the same size, irrespective of the variation in demand for the objects which they contain.

The bins herein illustrated are made in the form of a gigantic cabinet. Flat pieces of steel form the back and dividing partitions, upright and horizontal, and stove bolts through the angles make the entire bin secure and permit of adjustment. The shelves are held at the front by shelf supports, when it is desired to use the shelf as a bin to prevent small material from falling out, but when to be used simply as a shelf it is supported by a hanger.

The general design may be likened to the ordinary egg crate. It is made up of a continuous center partition or back, the full length of the bin. This center partition, which is a back for a

single face bin, serves as a center of dividing back partition for a double face bin. The uprights at right angles to the center partition or back carry a part of the shelf load, the shelves being attached to them at the front and back by stove bolts. Besides the back and uprights, the bottom and top shelves tie the construction firmly together. The bin section can be erected with ordinary labor, the only tool necessary being something to tighten the stove bolts.

These bins have been put through some severe and conclusive tests, which are clearly shown in the accompanying illustrations, with the idea, of course, to prove their strength and utility. One stringent test was the placing of heavy loads in the various compartments of a section; slabs of spelter, averaging 63 lbs. each, being used. The bins were loaded from 819 to 1,827 lbs., and with a total weight of spelter in the section of 15,220 lbs.—more than 7½ tons—there was no apparent deflection at any point.

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TRUCK.

General.—Trucks may have either the built-up metal or cast steel frames, and may be either of the four-wheel or six-wheel type, within the limit of wheel loads given below. For cars equipped with one cast iron brake shoe per wheel the effective maximum emergency brake shoe pressure must not exceed 18,000 lbs. per shoe. When two brake shoes per wheel, or one shoe per wheel having a higher coefficient of friction than cast iron are used, the wheel loads may be increased to the allowable carrying capacity of the M. C. B. standard rules.

Wheel Loads.—Maximum weight of loaded cars must not exceed 15,000 lbs. per wheel for M. C. B. standard axle having 5 in. x 9 in. journals, or 18,000 lbs. per wheel for M. C. B. standard axle having 5½ in. x 10 in. journals.

Details.—Wheels shall be either all-steel or steel-tired. All other truck details, including body and truck center plates and side bearings, shall be in accordance with M. C. B. requirements and the practice of the railway for whose service the cars are built.

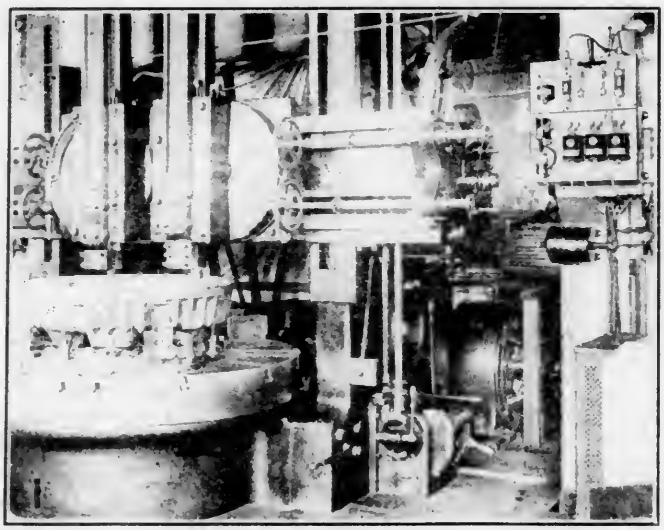
Painting.—The painting of car body and trucks shall be in accordance with the railway company's specifications for steel cars.

Lettering and Numbers.—The lettering and numbers of postal cars to conform to R. M. S. requirements and the railway company's standards.

AUTOMATIC CONTROLLERS FOR MOTOR DRIVEN MACHINERY

The Electric Controller & Manufacturing Company, of Cleveland, O., has recently placed on the market a line of automatic controllers designed for the specific purpose of giving the utmost convenience in the control of motor driven machinery. It has been estimated that the output of many machines can be increased 20 per cent. by the central grouping and convenient arrangement of all the operating levers. Handiness of control is recognized as being very important in securing the utmost production from a machine, and the automatic controllers described in this article were designed to provide this handiness of control for starting, stopping, or reversing the motor and machine.

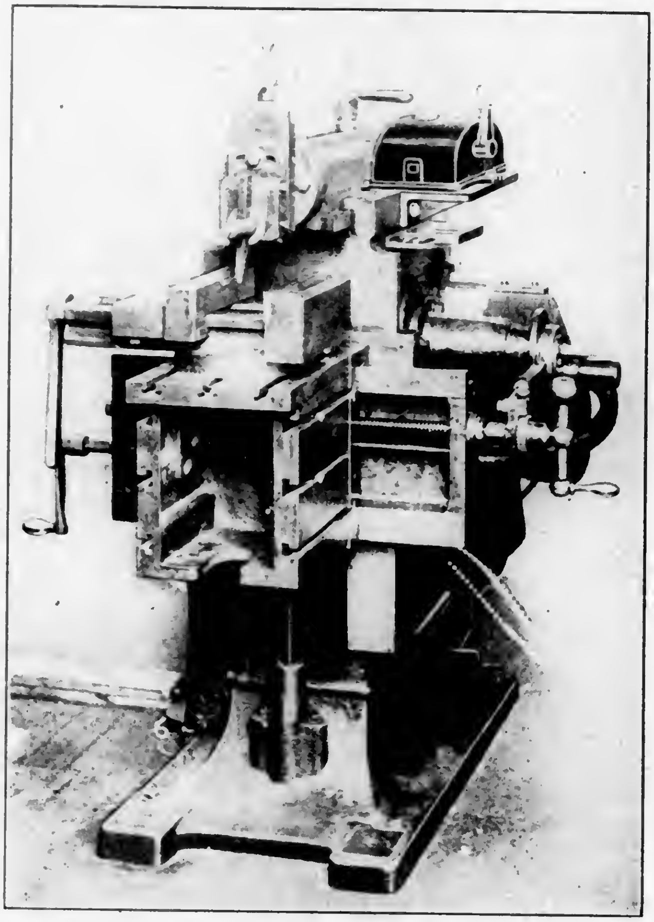
The controller consists of a small operator switch and an accelerating unit. The controllers are built in three types to



AUTOMATIC CONTROLLER ON BORING MILL.

secure: (1st) non-reversing and dynamic braking; (2nd) reversing without dynamic braking; (3rd) reversing and dynamic braking. In each type a variety of four different forms of accelerating units are offered. These accelerating units vary in their design from a simple train of accelerating switches up to a unit having a fused service switch, a train of accelerating switches, and complete circuit-breaker features.

The accelerating unit automatically accelerates or decelerates



MOTOR DRIVEN SHAPER EQUIPPED WITH AUTOMATIC CONTROLLER.

the motor through the action of series wound accelerating switches which possess the remarkable characteristic of acting, not only as switches, but as current limit relays as well. When the current in the winding of one of these switches exceeds a predetermined value the switch locks open and cannot close until the current is reduced to the proper value.

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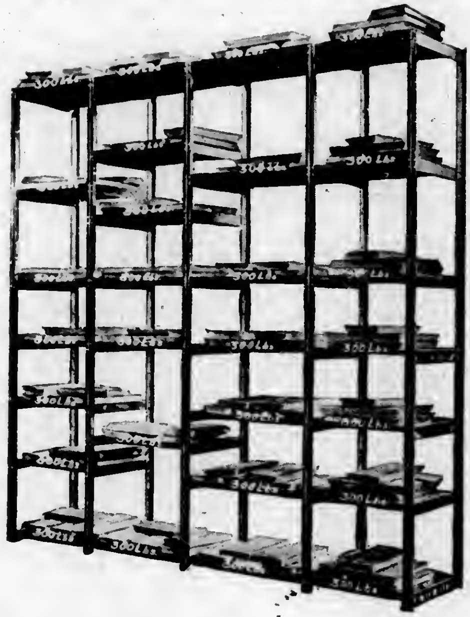

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VARIABLE LEAD ATTACHMENT FOR RADIAL VALVE GEARS

The invention herein described and illustrated relates to locomotive valve gearing of the so-called radial type, and has particular reference to an improvement over the Walschaert, in providing an attachment whereby the lead may be increased or decreased, as desired, instead of maintaining a constant lead as in the designs now employed.

As set forth by the inventor, R. M. Wiggins, of Trenton, Mo., a further object is to provide a valve gear with a "lead controller" operated from the locomotive cab which does not necessitate the provision of additional valves and consequent extra valve gear, but which forms a simple attachment to the mechanism now commonly employed. It is also sought to obtain a better distribution and hence less consumption of steam with the resultant fuel and water economies. Mr. Wiggins claims that this lead controller is adapted to increase the lead, to accelerate and to maintain a comparatively high rate of speed, and to decrease the lead to effect a correspondingly slow movement and more powerful stroke.

The action of the device may be readily understood from the two drawings, Fig. 1 being a side elevation, showing the improved gear adjusted to increase the lead, and Fig. 2 a similar view disclosing the valves "line and line," or completely closing the admission port. Explanatory of the attachment it may be said that the valve rod (26) is secured at its outer extremity to a sliding block (27) mounted upon a guide rod (28). This latter is preferably of circular form and adapted for passage through a corresponding opening formed in the lower end of block (27). A floating lever (29) is hinged upon the sliding block (27) by a pin in its upper end, and above this point it is formed with an accurate longitudinal slotted portion (31) to form a fixed link. A connecting block (32) is mounted to slide upon the guide rod (28) and carries the inner end of a radius blade (33) extending toward the fixed link. A sliding block is mounted in the link slot and is attached to the outer end of the radius blade. An auxiliary lifting shaft is journaled above the connecting block (32) and this bell crank form is connected on the upper arm by a rod to the hand lever in the cab, and on the lower arm by means of the hanger (36) to about the center of the radius blade (33).

Referring to Fig. 1, it will be noted that the hanger (36) is raised to draw the sliding block to the top of the link slot. In this position the piston valve is moved so as to partially close the admission port and advance the lead of the valves. In Fig. 2 the hanger is moved down to hold the block in the lower end of the link so as to position the valve line and line, completely closing the admission port. In this instance the lead is retarded and the exhaust port is disclosed as being slightly open. The

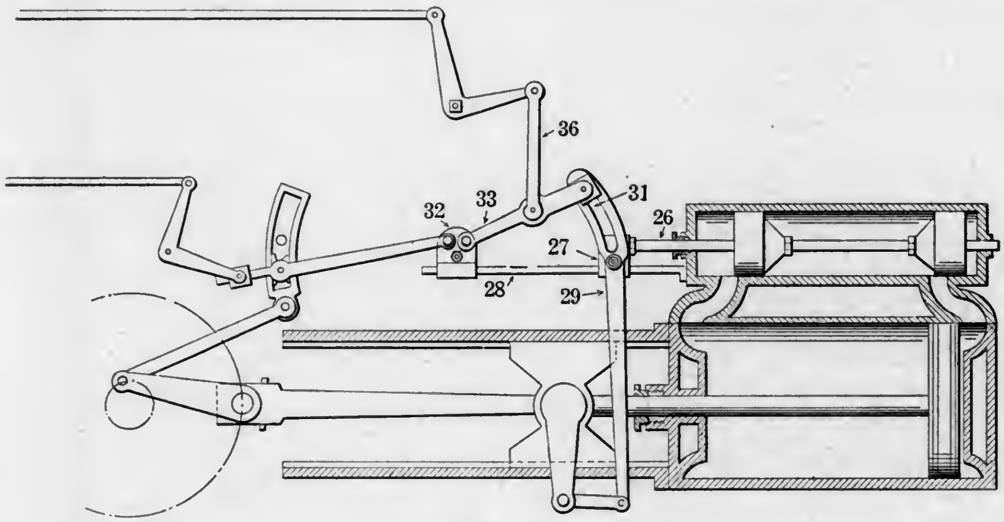


FIG. 1.

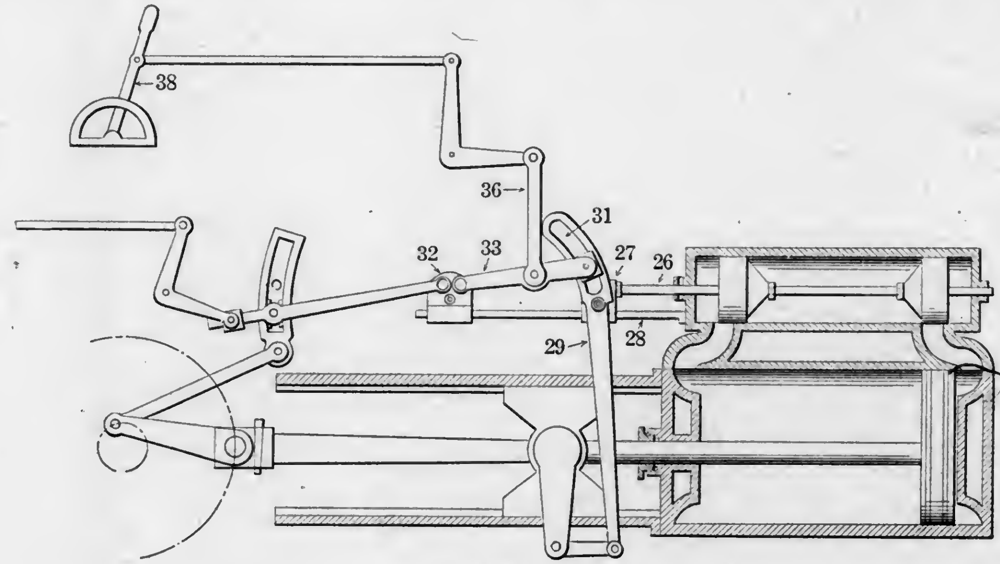
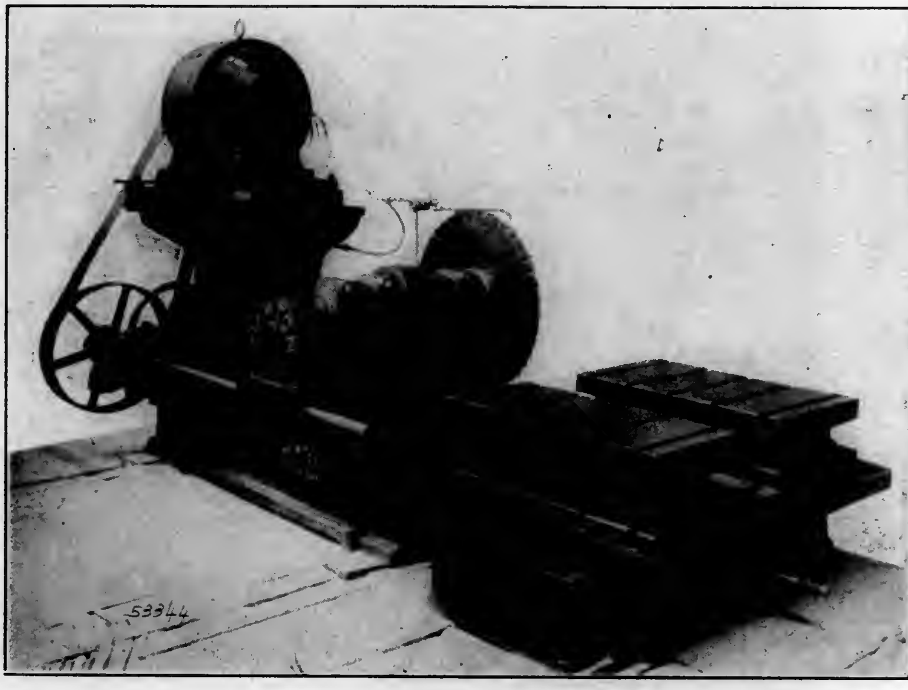


FIG. 2.

hanger (36) may be adjusted into various vertical positions by means of the hand lever to move the valves within the steam chest to increase or decrease the lead.

HIGH PRODUCTION COLD METAL SAW

In continuation of the effort to secure the very highest possible development in metal sawing machines, the Newton Machine Tool Works, of Philadelphia, Pa., has recently placed on the market a new design which embodies all the best features known for the successful operation of such machines at the present time. The machine illustrated is particularly intended for use in steel foundries and in accordance with the manufacturers' specifications for such is fitted with special provision to increase the life, as the sand and grit in steel foundries is very injurious to the flat and circular bearing surfaces. For this reason all shears are very broad; the bearings are bushed where necessary and the spline shafts are fitted with collars to rotate with the shaft in the bearings, to prevent the escape of oil.



VERY POWERFUL FOUNDRY SAW.

The machine is of the spindle driven type, the spindle revolving in bushed capped bearings, and is supported at each end. The driving spindle gear is mounted between them. The drive to the spindle is by means of broad face 60 carbon hammered steel gears and the teeth of the driving pinion meshing with the spindle gear are cut from the solid worm wheel shaft. The driving worm wheel is one solid bronze casting and the driving worm is of hardened steel with teeth of steel lead, and both the worm and worm wheel are encased for continual lubrication. The bearing for the worm wheel is cast solid with the saddle, and to prevent the escape of oil through keyways and also to prolong the life of the bearing special extra bushings are mounted on the spline shafts in both ends of this bearing. The saddle is of very heavy construction, has square bearings on the base with interlocking gibs cast solid and the adjustments are made by means of taper shoes. The saddle has a bearing its full length on the shears, and the feed screw has a bearing on both ends to permit of its always being maintained in tension.

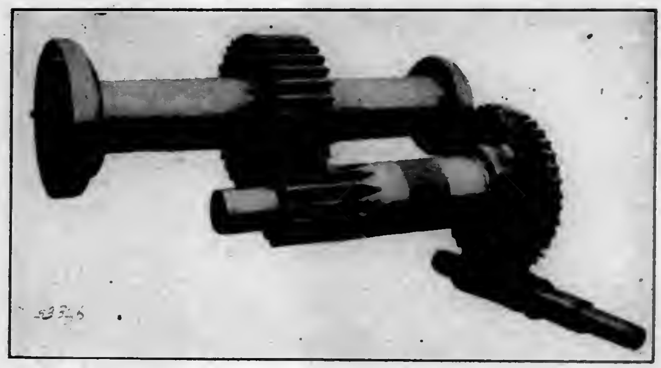
Gear feed is provided, having six changes, with quick return, and by the use of a double throw switch or reversing motor this fast power traverse is available in both directions. The saddle is fitted with adjustable, automatic and positive safety release to the feed and fast traverse.

The work table is 36 in. wide by 48 in. long, entirely surrounded by an oil pan, is fitted with five "T" slots and there is 20 in. of hand cross adjustment. The auxiliary parallels are each 16 in. wide, 36 in. long, 9 in. high and fitted with five "T" slots. These are provided to permit of clamping the work closely on each side of the saw blade and still maintain clearance for the latter. This feature is particularly desirable for making two cuts on one piece in the same setting.

The diameter of the saw blade, which is the Premier inserted tooth type, is 32 in. The capacity for gates or risers is for 9½ in. diameters in one cut, and the length of travel of feed to the saddle is 14 in. The smaller illustration very clearly shows the drive; the teeth of the spindle cut from the worm wheel shaft; the method of supporting the pinion on both sides of the teeth; the solid bronze worm wheel having teeth of steel lead; the hardened steel worm and the roller thrust bearings. The ground spindle is fitted on the saw end with three circular keys for driving the blade, and three bolt holes for holding the blade in place. On the opposite end are adjusting nuts to take up the wear. The simplicity of this drive as a whole with its evident great strength and rigidity forms probably the most interesting feature in the consideration of the general design.

This particular machine is driven by a 10-horsepower Fairbanks, Morse Co. type B motor No. 5, running at 1,200 r. p. m. To insure the highest efficiency from the motor connection an extra long belt center is provided, and the top of the bracket is arranged to permit of slight adjustment of the motor to tighten the belt.

To the features of this general design, in addition to the heavy construction, the builders attribute their success in making a number of sawing cuts through a 5½ in. diameter 35 carbon bar in 1 min. and 35 seconds. This, of course, could not be maintained in actual practice, except with the knowledge that the machine would be worn so badly that its efficiency would be very low in a very short time.



DETAILS OF DRIVE.

It is Estimated that the Railroads of Argentine will import 300,000 tons of rails during 1911. That country has about 19,000 miles of track and many new branches are being constructed each year.

NEW CABINET TURRET LATHE WITH FRICTION-GEARED HEAD

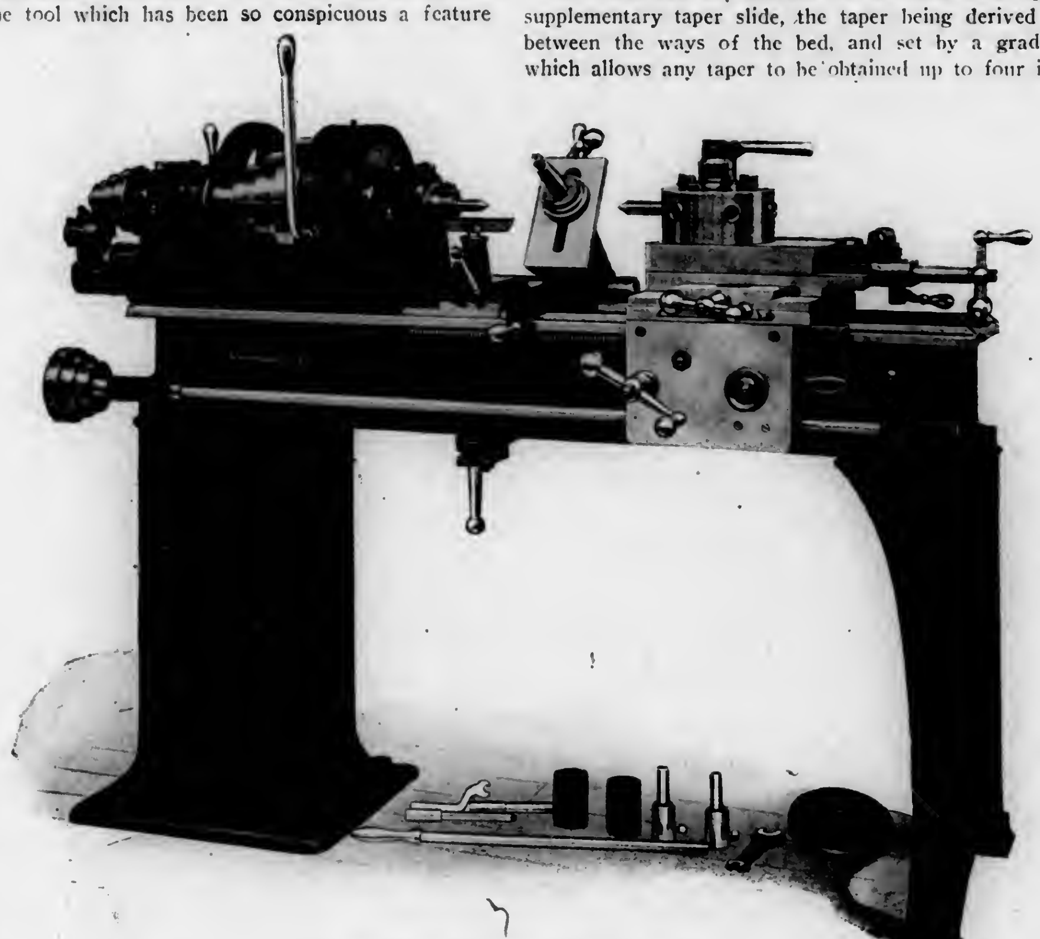
The finely designed turret lathe which forms the subject of the accompanying illustration is the latest production of the Springfield Machine Tool Co., of Springfield, O., and may be said to represent another advance in the development of this popular machine tool which has been so conspicuous a feature during the last few years in the mechanical world. In the rush of production and competition many important improvements have possibly been overlooked by those either directly or indirectly interested in the general subject of machine tool design, and it is therefore timely to allude to the distinctive features of merit which may be embodied in any new creation on the market.

In this instance the builders have worked successfully toward the end desired—to include in this machine new details and improvements which must result in further efficiency, not only in economy of operation, but in increased range of work. Particularly in this connection it will be noticed that the clutch mechanism of the turret head makes it capable of being handled much quicker than the old style—a feature which will be particularly interesting to brass workers who are always on the lookout for machinery to cheapen their product.

Some special features in connection with the turret are of interest. It is provided with automatic engine feed, with three changes, which may be reversed by the handle at the left-hand side of the apron, and directly at the hand of the operator. There is also a longitudinal movement by either lever or screw. The top slide of the turret rests upon a slide having a right angle hand movement operated by a screw to the front of the machine, which allows a large range for facing off work held in the chuck. When using this hand set-over, the holes in the turret can always be brought central with the spindle by a positive stop. The stop can be quickly removed when the tools are to be used on the back side of the spindle center.

The turret is further designed so that one slight backward movement of the blade loosens it, and at the same time withdraws the locking pin; while a slight forward movement produces the fractional revolution of the turret for the next tool, and at the same time locking and tightening it—the entire operation being effected in an instant by one hand.

The slide has an additional cross movement operated by a supplementary taper slide, the taper being derived from a bar between the ways of the bed, and set by a graduated index, which allows any taper to be obtained up to four inches to the foot. This obviates the necessity of setting over the headstock for taper boring or turning, and by this new taper attachment work can be faced off square when taper work is completed, without any change. When used for straight work the taper slide is locked to the saddle by a tapered toolsteel pin, having a square head for its ready removal.



THE SPRINGFIELD CABINET TURRET LATHE

The automatic feed allows pieces of any length to be operated on within the range of the machine. When this feed is not used the saddle may be locked to the bed by the gib screw at the right-hand side of the apron.

Another new feature of the machine permits left-hand threads to be cut with right-hand leaders thus saving the cost and annoyance of a separate set of left-hand hobs and leaders. The different pitches of threads are obtained by the well-known follower and leader device. One leader and follower to cut 11½ threads per inch, also one hob to cut the follower are furnished as part of this equipment. The machine rests upon one cabinet and one plain leg, to the former of which can be fitted shelving for the reception of tools, chucks, etc.

The general dimensions of the 15 in. by 5 ft. machine are as follows:

Diameter of turret	7½ in.
Length of carriage	12 "
Movement of top slide	5¼ "
Cross movement of top slide	6¼ "
Diameter of turret holes	⅞ "
Number of holes	6
Width of belt	2 in.
Back gear ratio	10 to 1
Hole in spindle	1 in.
Shipping weight	1,700 lbs.

NEW MACHINE TOOL FOR CUTTING SQUARE HOLES

Much has been written pertaining to the problem of boring square holes, and attempts towards the construction of a practical tool for this class of work have been numerous.* Various designs in the shape of attachments for ordinary lathes or milling machines, etc., have been recently offered in the market, but they have generally failed to produce satisfactory results, owing to the difficulties in the proper mounting of the device on any standard machine tool.

Experiments along this line have conclusively proved that such attachments cannot be fastened rigidly enough to withstand the amount of side thrust caused by the eccentric jarring motion of the cutter, at right angles to the working spindle. It was further demonstrated that the carriage of the average lathe did not offer sufficient stiffness to hold the working pieces rigidly in position, which latter is one of the vital points in obtaining perfect square holes.

The R. K. Le Blond Machine Tool Company, of Cincinnati, O., has taken an interest in the solution of this problem, and after careful study of the subject, and especially of its former weaknesses, has reached the conclusion that this work can only be satisfactorily performed with a special machine tool, in which arrangements for cutting square holes are embodied in the design, thus guaranteeing absolute rigidity and accuracy. Considering, however, that a machine which would do nothing else but cut square holes would be too great an investment for many customers a combination machine tool has been designed which is not only adapted for milling square holes, but also possesses all the features of a standard milling machine.

The principle used in this work is the same as employed in other devices, viz., the revolution of a triangular-shaped bit, similar to an end mill, in a stationary master guide, which in appearance is much like a regular drill chuck. Entirely different, however, from all previous devices this stationary guiding chuck is fastened directly to the column of the machine by means of a flange which entirely eliminates the former troubles arising from lost motion.

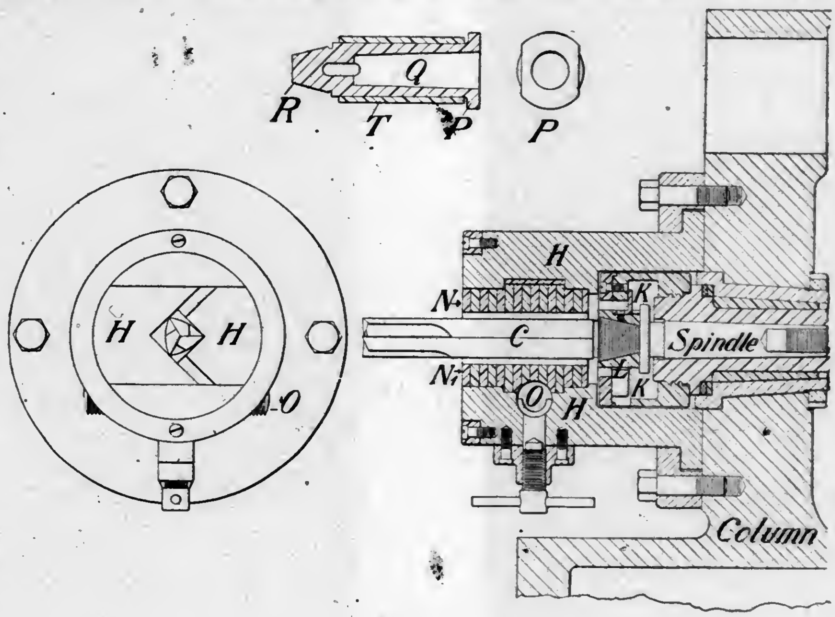


FIG. 2.

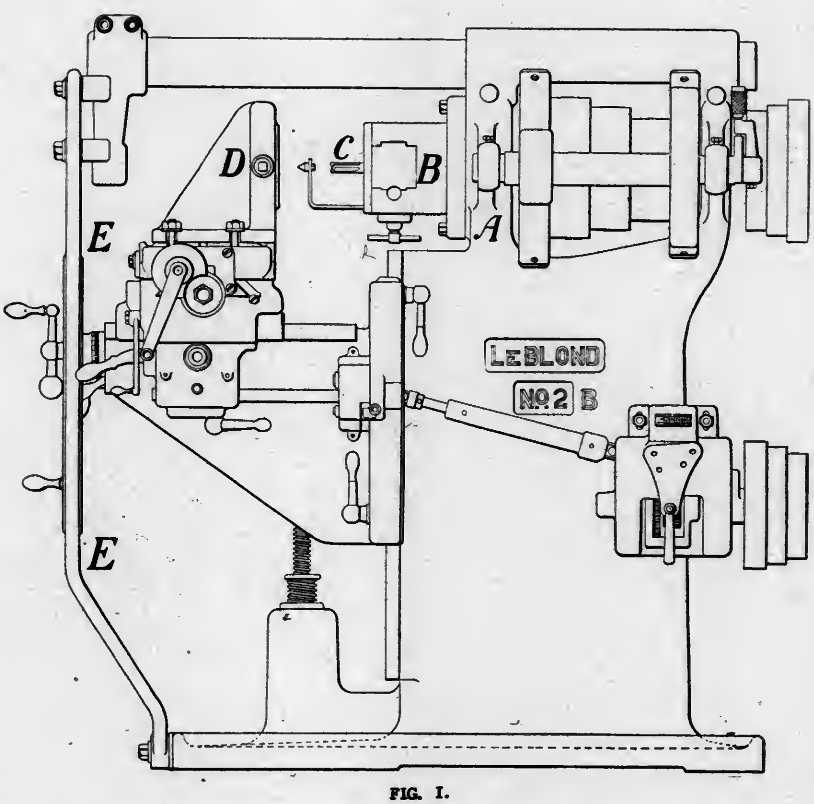


FIG. I.

The cutter receives its motion from a special driving member which is fastened to the nose of the spindle. This driving member not only causes the cutter to rotate, but at the same time gives it freedom to travel eccentrically in the master guide. The whole arrangement for cutting square holes, simple in itself, is easily detached and the machine is ready for regular milling work or vice-versa.

Referring to Fig. 1 in the accompanying drawings, a side view is shown of the complete machine. (A) is the column with the main spindle bearing, (B) detachable chuck for cutting square holes, (C) the cutter, (D) special vise for holding work, and (E) a special brace connecting knee with overhanging arm and base. Fig. 2 shows an axial cross section through the square hole cutting arrangement, which latter consists mainly of two separate bodies, viz., the driving member (K), which is screwed to the nose of the spindle, and the stationary guiding chuck (H), which is bolted to the column over the main bearing. The driving member contains a floating driving dog (L), into which cutters (C) engage by means of a taper thread. Behind this dog is a floating thrust plate which takes up the end thrust of the drills. The stationary guiding chuck contains the master guide, which consists of two jaws (N) and (N_1), forming an adjustable square guiding hole, in which the drill (C) is forced to describe its particular cam motion. (O) is a right and left-hand screw for opening and closing these in accordance with the size of drill used. The range for boring square holes is from ¼ in. to 2 in.

For boring round holes in connection with the arrangement for cutting square holes the means employed are represented in the device above, Fig. 2, in which it will be seen that a round bushing (T) is inserted in the square guiding hole, and this

* A German machine for this purpose was illustrated in this Journal, January, 1909.

serves as a bearing for the shank (R), which contains a regular Morse taper (Q). This shank is fastened in the driving member by means of a taper thread (R), and describes a regular revolution inside the bushing (T). Any size twist drill can be inserted in the Morse cone and the whole arrangement is easily taken off.

It is evident that the installation of such a machine tool, which is always handy as a regular plain miller, will open new fields of manufacture and will be of value to every toolroom for special work of all kinds.

Recent Papers Presented Before The Railroad Clubs.

Some Recent Developments in Car Heating and Ventilation

CANADIAN RAILWAY CLUB.

The above subject is a most important one and it covers a very broad field. Therefore the excellent paper read by Lewis C. Ord, general car inspector, Angus shop of the Canadian Pacific Ry., was most appreciatively received by the membership of this club who were present at the October meeting. The paper was most interesting and reflected a deep study of the two subjects. From an instructive standpoint it adds greatly to the knowledge of these matters which railway men are now studying more than ever before, and which have also a direct appeal to the traveling public. The only competition the railroads recognize in passenger traffic to-day is their service, and the public have been awakened to the importance of good heating and good ventilation in relation to its comfort. The railroad which actually gives good ventilation and heating, and incidentally lets the public know about its efforts, will get the traffic, and thereby add to its revenue. The only way to obtain a thorough and satisfactory system in dealing with the dual question is to follow along the lines indicated by Mr. Ord in his valuable paper, and by others who are thoroughly, scientifically and practically investigating the subject in every detail, decide on what is required and then install the system which best appears to realize the ideal. The traveling public, as above stated, should know what is being done to secure their comfort and one-half of the present heard complaints will vanish. It was said during this meeting that the present appliances do not adequately take care of the situation, and it is encouraging to know that the subject is being given the amount of care and thought which Mr. Ord's paper indicates.

Tool Steel

NEW YORK RAILROAD CLUB.

The necessity of accurate control of the temperature at which steels of different carbon content are forged and annealed was a very interesting feature of a valuable paper read before this club on November 17 by W. B. Sullivan, of the Carpenter Steel Company, Philadelphia, Pa. It was pointed out that by a judicious application of heat it is possible to obtain almost any desired combination of ferrite, pearlite and martensite, and emphasis was laid on the fact that tools when properly handled should be heated first to the proper temperature or critical point before being quenched. Even at the proper temperature tools should not be allowed to soak too long, it was further explained, as this procedure tends to produce decarbonization on the surface.

The author pointed out that the hardness of a piece of steel, properly treated, is governed by the size and character of the steel and by the temperature and character of the bath. The conclusion reached, based on general principles, was that for small sections lower temperatures should be used than for large pieces. The degree of hardness is found to be dependent upon the rapidity with which the heat is extracted from the steel, and it is found that a bath of high temperature will produce less hardness. Tests made by the Carpenter Steel Company showed that, compared with water on a basis of unity, No. 1 mineral oil had a tempering quality of 0.241; cottonseed oil, 0.161, and fish oil, 0.149.

In his paper the author included an outline of the proper grades and tempers of carbon tool steel for various uses. Temper No. 1 contains 0.70 to 0.80 per cent. carbon; No. 2, 0.80 to 0.90 per cent. carbon; No. 3, 0.90 to 1 per cent. carbon; No. 4, 1 to 1.15 per cent. carbon; No. 5, 1.15 to 1.25 per cent. carbon. Grade A is the highest grade steel selling for about 16 cents per pound. Grade B sells for 13 cents per pound and Grade C for 10 cents per pound. Grade D is ordinary tool steel selling for about 7 cents per pound. The following outline shows the proper selection of temper and grade and the proper heat treatment:

Temper No. 1.	Grade.	
Crowbars	D	
Pinchbars	D	Should not be heated over 1,800 deg. Fahr. for forging. Hardens at 1,485 deg. Fahr. Temper drawn to suit character of work. Should be annealed at 1,300-1,350.
Pick Points	D	
Wrenches	D	
Sledges	C	
Hammers	C	
Rivet Sets	B	
Temper No. 2.		Should not be heated over 1,800 deg. Fahr. for forging. Hardens at 1,480 deg. Fahr. Temper drawn to suit character of work. Should be annealed at 1,300-1,350.
Smith Tools	C	
Track Tools	C	
Boilermakers' Tools	C	
Temper No. 3.		
Cold Chisels	C	Should not be heated over 1,750 deg. Fahr. for forging. Hardens at 1,465 deg. Fahr. Temper drawn to suit character of work. Should be annealed at 1,300-1,350.
Hot Chisels	C	
Rock Drills	C	
Shear Blades	B	
Punching Toools	B	
Temper No. 4.		
Machine Drills	B	
Counter Bores	B	Should not be heated over 1,700 deg. Fahr. for forging. Hardens at 1,460 deg. Fahr. Temper drawn to suit character of work. Should be annealed at 1,300-1,350.
Milling Cutters	B	
General Machine Shop Tools	B	
Carbon Lathe Tools	A	
Taps	A	
Dies	A	
Reamers	A	
Temper No. 5.		Should not be heated over 1,700 deg. Fahr. for forging. Hardens at 1,455 deg. Fahr. Temper drawn to suit character of work. Should be annealed at 1,300-1,350.
Brass Tools	A	
Finishing Tools	A	
Small Machine Shop Tools	A	

Scientific Management

NEW ENGLAND RAILROAD CLUB.

This club is to be congratulated on having secured a paper on the above subject by Frederick W. Taylor for presentation at its October meeting. The question has, of course, a direct bearing on railroad work because in many of its phases railroading suffers from very violent fluctuations in the demand for certain kinds of work. Mr. Taylor's paper may be regarded as an authoritative exposition of true scientific management. It was of particular value on this occasion as an important phase of the problem of the railroad manager was indicated by the extreme viewpoints of two speakers, that is, the idealistic viewpoint of the originator of scientific management and the frankly obstructive attitude of Mr. T. A. Connor, who represents the machinists' labor unions. Professor W. J. Cunningham believed that somewhere between these two extreme views must be found a neutral ground. He mentioned, following his experience in studying at first hand conditions on the Santa Fe where scientific management is employed, that the latter as elucidated by

Mr. Taylor is not in effect on that system, but rather a compromise between it and that of other efficiency experts. It was pronounced as in possession of virtues as well as defects, but the speaker's observations led him to believe that shop men, foremen and superintendents were all enthusiastic over the results, although the same enthusiasm was not apparent in other branches of the service. The paper was very favorably received by the members in general, and its careful perusal is recommended to those interested.

Engine Failures

NORTHERN RAILWAY CLUB.

This paper was presented before the above club at the October meeting. In view of the fact that it was prepared by a traveling engineer, Nels Osgard, of the Great Northern Ry. at Superior, Wis., it attracted a considerable attendance and was accorded the thorough discussion which the subject, although somewhat hackneyed, generally inspires. During his remarks Mr. Osgard opined that much carelessness is present in looking over the reports that are made of work to be done in the roundhouse, and expressed himself as satisfied that in many cases half the reported work is overlooked, due to not having force enough to take care. Mr. Seddon, speaking from the roundhouse viewpoint, stated in four or five years as foreman of that department he had not let an engine out until positive the same was O. K., and so it goes. There is no doubt but that the general subject of engine failures will always remain of very great importance, and papers thereon when discussed with the interest displayed at this meeting are valuable in conveying the experiences of others in combating the varying features of the problem. The subject is commented at some length elsewhere in this issue.

The Distribution of Instructions and Information in Large Industries

CENTRAL RAILWAY CLUB.

The November meeting of this club was signalized by the reading of a most interesting paper on the above subject by F. M. Whyte. In it the author pointed out that as organizations increase in size the difficulty becomes more apparent to harmonize by instructions and information, the various elements of the organizations to one main idea, or to the ideas of one man, or a group of men. In the consideration of methods which might be employed to bring this about the paper mentioned the distribution of detail information through standards, through circulars, and particularly through traveling representatives.

PERSONALS

W. H. DONLEY succeeds F. G. Colwell as master mechanic of the Illinois Central R. R. at E. St. Louis, Ill.

R. D. MALLOY succeeds Edward Wees as general foreman of the Pere Marquette Ry. at Frankfort, Mich.

H. F. CAMPBELL has been made general foreman at Chattanooga, Alabama Great Southern Ry., succeeding H. B. Hayes, promoted.

W. P. HOBSON has been appointed superintendent of motive power on the Chesapeake & Ohio Ry., succeeding W. T. Smith, retired.

H. A. UHLER has been appointed road foreman of engines on the National Railways of Mexico, with office at Monterey, Mexico.

T. F. DREYFUS has been appointed master mechanic of the Baltimore & Ohio R. R., with office at Benwood, W. Va., succeeding D. H. Speakman.

A. S. HOWE has been appointed superintendent of motive power of the Nevada, California, Oregon Ry., to succeed W. D. Gardner. Mr. Howe's office will be at Reno, Nev.

JOHN BURNS has been appointed master mechanic of the Eastern division of the Canadian Pacific Ry., vice J. B. Elliott, retired. The office is at Montreal, Que.

CHARLES J. SCUDDER, master mechanic of the Pere Marquette R. R., at Saginaw, Mich., has resigned to take a position as district boiler inspector with the Interstate Commerce Commission.

W. L. KELLOGG, superintendent of motive power of the Cincinnati, Hamilton & Dayton Ry., has been appointed in a similar capacity on the Pere Marquette Ry., with office at Detroit, Mich.

H. H. HALE has been appointed superintendent of motive power of the Cincinnati, Hamilton & Dayton Ry. at Cincinnati, O., succeeding W. L. Kellogg.

H. B. HAYES has been made master mechanic of the Alabama Great Southern Ry. at Birmingham, Ala., vice Joseph Quigley, appointed master mechanic of the Queen & Crescent Ry. at Ferguson, Ky., vice F. O. Sechrist, resigned.

BRUCE W. BENEDICT, for several years in the motive power department of the Atchison, Topeka & Santa Fe Railway, has been appointed Director of the Shop Laboratories in the Department of Mechanical Engineering at the University of Illinois.

W. C. STEARS, master mechanic of the Lima district of the Cincinnati, Hamilton & Dayton Ry., with office at Lima, Ohio, has been appointed master mechanic of the Indianapolis and Springfield divisions of the same road, with office at Moorefield, Ind., succeeding F. C. Pickard, who resigned to take a position with the Pere Marquette R. R.

CATALOGS

BLOW-OFF VALVES.—A booklet illustrating and describing the Nelson blow-off valve is being distributed by the Nelson Valve Co., Philadelphia, Pa. The booklet is thoroughly explanatory of the well-known appliances and contains several important items of information for those in charge of their operation and maintenance.

ELECTRICAL EQUIPMENT.—The General Electric Company, of Schenectady, N. Y., in Bulletins Nos. 4883, 4886, 4891 and 4892, respectively, describe the Curtis Steam Turbine Generator, electricity in coal mines, electric railway equipment, and the battery truck crane. These bulletins are presented in the usual attractive form which characterizes all of the literature issued by this company, and each constitutes practically the last word on the subject to which it refers.

LOCOMOTIVE SUPERHEATERS.—"The Application of Superheated Steam to the Locomotive" is the title of a most instructive pamphlet published by the Locomotive Superheater Company of 30 Church St., New York, N. Y. The historical aspect of the device is considered and the text elaborates on the general construction of the Schmidt superheater, which is now applied to about 9,000 locomotives, operating on more than 200 railroads. The book also includes tabulated records of some very interesting tests which afford data of much value.

ASBESTOS SHINGLES.—A general description of J-M transite asbestos shingles is presented in a booklet issued by the H. W. Johns-Mansville Co., and their striking advantages over other types of roofing material for buildings are pointed out. In view of the fact that five underwriters and municipal authorities are establishing stringent requirements in building construction at this time the indestructibility and fire proofing qualities of these asbestos shingles become of particular interest. The catalog is profusely illustrated with photographs of buildings installed with the material, and contains considerable descriptive matter concerning its application.

STEEL SHAPES.—The new "Shape Book" just issued by the Carnegie Steel Company, with a few unimportant exceptions, contains profiles of all the sections rolled on the structural, plate, bar and rail mills of that company, together with tables and other data in regard to these products. It supersedes and cancels the book of shapes issued in 1903, together with all supplements thereto. The present issue is a substantial book of 256 pages, 5 by 7½ in., and is in the usual handsomely bound form of those which have preceded it. The data tables in connection with the illustrations have been compiled with great care and afford a fund of inexhaustible information for those interested in the general subject of steel shapes.

STEAM ACETYLENE GENERATORS.—The Alexander Milburn Company, of Baltimore, Md., manufacturers of the Alexander steam acetylene generator, has issued a very attractive catalog illustrating and describing the device. The problem of lighting headlights is now seriously engaging the attention of railroads and the device is of special interest at this time. It is the newest in generating acetylene gas for this purpose, using steam from the locomotive for the purpose. Any pressure of steam from as low as half a pound to as high as 200 pounds will work satisfactorily, hence exhaust steam can be employed, the quantity in any case being practically negligible. The catalog will repay a perusal by all interested in the subject of acetylene lighting for headlights, railroad coaches, steam yachts, or other requirements.

Heating, Forging and Welding Furnaces.—These appliances are treated at considerable length in a handsomely illustrated catalog of 32 pages just issued by Tate, Jones & Co., engineers and manufacturers, of Pittsburgh, Pa. The furnaces manufactured by this firm for the above purposes use either oil or gas fuel and may be run at their full capacity. As illustrated and described in the pages of the catalog, the assurance is conveyed that these furnacs will do the work more thoroughly, more expeditiously and more economically than the usual makeshifts, because they are not merely haphazard assemblies of cast iron and brick, but, on the contrary, are successful designs, founded on mechanical and metallurgical theory supported by many years of practical experience in oil and gas furnace building.

Locomotive Coaling Stations.—The Roberts and Schaeffer Co., engineers and contractors, of Chicago, Ill., in a very artistic, recently issued catalog, portray most effectively the merits of the Holmen locomotive coaling station. The plan employed in the presentation of this matter was to graphically impress through photographs of various installations the gneral utility of the structure, and the varying range of work of which it is capable. In this the compiler has succeeded admirably, as in the catalog no less than twenty-five coaling stations from as many roads are illustrated, each of which is annotated with the proper descriptive text. As the illustrations depict practically all possible conditions which might be encountered in connection with the installation of coaling stations, this catalog must be of pronounced value to those charged with the consideration of such problems.

Box Frame Interpole Railway Motors.—Descriptive Leaflet 2373, issued by the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa., describes the No. 303-A box frame interpole motor manufactured by that company. Complete specifications for the motor, brief descriptions of the important parts, and performance curves are given on the sheet. Particular stress is laid upon the fact that the motor is equipped with axle-bearing dust guards, which prevent the entrance of dirt and sand into the axle bearings, and thereby greatly prolong the life of bearings and gears. The leaflet is 8½ x 11 inches, so that it readily binds in with the usual letter size sheets. Descriptive Leaflet 2374, recently issued by the same company, gives specifications and brief descriptions of the parts of that company's box frame interpole railway motor No. 310-C. This leaflet is similar in general make-up to the one above described.

Steam Driven Compressors.—The Ingersoll-Rand Co., 11 Broadway, New York City, have issued a new catalog, Form 3211, bulletin of 20 pages, descriptive of "Imperial Type X" duplex steam driven compressors. The catalog shows several views of the machine in section, and gives tables of standard sizes and capacities. These machines have massive, well-braced structure, unusually generous bearing surfaces, mechanically actuated air intake valves with large, direct passages, and cushioned discharge valves. The air cylinders of all "Imperial" compressors have water-jacketed barrels and heads, the latter being hooded for the admission of cool, clean air. The smaller compressors, up to 16 in. stroke, have overhung cylinders. On larger sizes the air cylinders are supported on a strong foot-piece resting upon a sole-plate on the foundation, and may be slid away on this sole-plate when it is necessary to detach the cylinder from the frame.

Silent Chain Driver.—In a well and appropriately illustrated booklet the Morse Chain Company, of Ithaca, N. Y., invites attention to a drive which is no longer experimental, but rather a distinct advancement in power transmission. It is worthy of consideration for almost any amount of power that may be required to be transmitted. The design and operation is clearly portrayed and described in the catalog, and the descriptive matter embodies a very interesting comparison between a 1,200 horsepower rope and an equal power chain drive in which the advantage and the economy of the latter is clearly demonstrated. The improved "Silent Chain" may be considered as a flexible rack, designed to keep automatically in proper pitch contact with the sprockets. It has a certain amount of elasticity due to the arch shaped links, and thus, to a greater or less extent, is driving through an elastic medium without shock or noise, a feature which makes it most desirable for general power transmission purposes.

Power Transmission Machinery.—This is the title of the latest catalog issued by the Jeffrey Manufacturing Co., of Columbus, O., one which is probably the most complete and up-to-date in existence. There are more subjects listed and there is more technical and real information thereon in this book than in any similar publication which has come under our notice. Besides listing dimensions and sizes of every part in this line, there is descriptive matter on the horsepowers of steel shafting, standard methods of key-seating, sizes and dimensions of couplings, hangers, pillow blocks, counter shafts, belt tighteners, clutches and quills. A feature is made of the Jeffrey improved split iron pulley, which may be readily clamped on the shaft without disturbing any other equipment, or may be easily removed when necessary. There are quite a number of details toward the end of the book, including horsepower of belts, method of calculating bending and torsional moments of shafts, etc., which are invaluable to the engineering fraternity.

Car Heating and Ventilation.—Burton W. Mudge & Co., of Chicago, Ill., have issued a very interesting and instructive catalog describing and illustrating the Garland heated and ventilated refrigerator car The subjects of ventilation, refrigeration and heating are treated separately and in detail, and the advantages accruing from the use of the Garland system are clearly set forth. This latter comprises a complete arrangement of ventilators and air intakes that keep a good circulation of fresh air passing through the car and lading. A perfected plan of refrigeration whereby the ice water from the ice tanks is made to circulate through pipes under the load instead of being discharged direct to the outside. The cold units in the ice water are therefore utilized and made to aid in the refrigeration of the car before the water is allowed to escape. A material saving in ice is therefore effected. During cold weather steam is supplied to the car from the engine, yard steam plug or other source and contents of cars is fully protected from frost.

Railroad Supplies.—The railroad department of the H. W. Johns-Manville Co., 100 William Street, New York City, is distributing a new 350-page catalog—No. 252—which illustrates, describes and lists in an unusually attractive way, their vast line of products supplied to steam railroads. Among the products shown, most of which are made of asbestos, magnesia or indurated fibre, we note pipe and boiler coverings, packings, cements, roofings, waterproofing materials, heat, cold, sound and electrical insulators, transite smoke jacks, transite asbestos wood, ceilinite insulation, conduit for pipes or wires, fuses, linolite electric lamps and accessories. The careful and systematic arrangement of the products to facilitate selecting and ordering them, the thorough indexing of material and the great amount of valuable data included, make this volume a veritable encyclopedia on the subject of steam railroad supplies. A comparison of this catalog with the preceding edition published three years ago, indicates by the greater number of products listed, more forcibly than words could do, the remarkable growth of the railroad department of this company.

Rock Drills.—The Ingersoll-Rand Co., 11 Broadway, New York City, have a new catalog, Form 4003, bulletin of 16 pages on "Little Giant" rock drills. The catalog shows the machine in section, and gives views of machines at work on the Panama Canal, etc. The distinctive characteristic of this tappet rock drill is the positive character of its valve movement. There being direct mechanical connection between valve and drill piston, when steam or air is admitted to the cylinder, the piston must move; and when the piston moves, the valve must be thrown, so that the operation of the drill is a certainty. The valve movement consists of three pieces: a valve, a rocker and a rocker pin. The rocker turns on the rocker pin and is so arranged that one or the other of its lower members is always in contact with the piston. Its upper member, ending in a globular shape, projects into the valve. When the piston moves, a curved surface slides under one of the rocker contacts, pushing the rocker upward and swinging the valve in the same direction as the piston is moving. On the reverse travel of the piston, this series of movements is exactly reversed. The throw of the valve covers and uncovers the supply and exhaust ports. The catalog gives a descriptive table of "Little Giant" Drills showing sizes and principal dimensions.

NOTES

Triumph Electric Company.—This company of Cincinnati, O., has recently opened a district office at No. 2219 Farmers' Bank Bldg., Pittsburgh. Formerly they were represented by the Doubleday-Hill Electric Company in that territory, but the rapidly increasing business made it seem advisable to have direct representation in this important center. D. D. Gill will be in charge of the new office.

Jerguson Manufacturing Co.—Announcement is made by the above company of Boston, Mass., that the Joseph M. Brown Company will be the representatives for the Jerguson Manufacturing Company in the states of Illinois, Missouri, Minnesota and Michigan for Klinger type water gauges and spare glasses, and also that the Dravo-Doyle Company will represent the Jerguson Manufacturing Company in the states of Pennsylvania, Ohio, Maryland, Delaware and West Virginia for the same appliances.

Best Manufacturing Co.—This company of Pittsburgh, Pa., announces that Charles E. Hague has been appointed as Philadelphia representative with headquarters at 1510 Land Title Building. He is to have charge of Eastern Pennsylvania, Baltimore and Washington territory. C. L. Stickney and Co. have also been appointed to represent the Best Mfg. Co. in the states of Washington and Oregon, with headquarters at 108 White Building, Seattle, Wash.

Remy Electric Co.—This company of Anderson, Ind., which recently absorbed the American Electric Headlight Co. and now makes the American electric headlight for steam locomotives, has purchased outright all patents, designs, good will and manufacturing rights of the Peters electric headlight. This department of the R. G. Peters Co., of Grand Rapids, Mich., has been moved to Anderson, and the Peters light will be owned, manufactured and sold by the Remy company. This absorption makes the latter the world's largest makers of locomotive electric headlights. The great demand for these within the past few years has been the cause of the Remy company entering the field on so large a scale, and its extensive facilities, together with advanced methods of manufacturing, guarantees the very best possible workmanship on the new devices.